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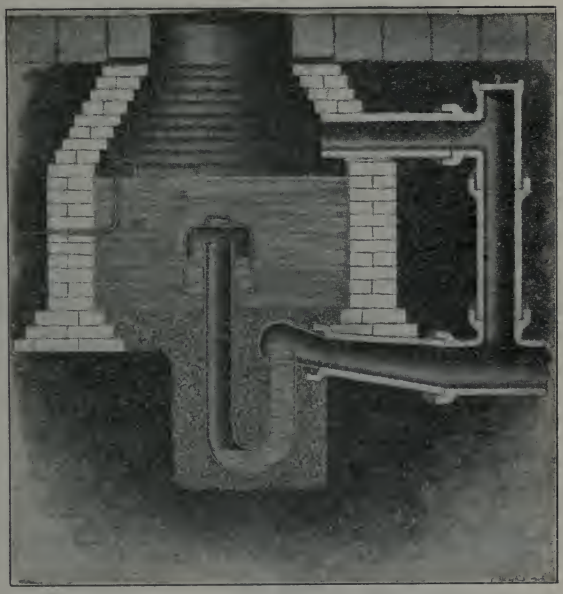

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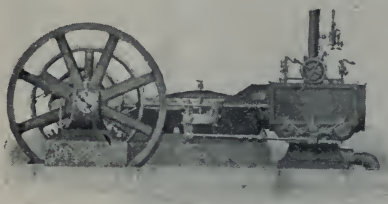

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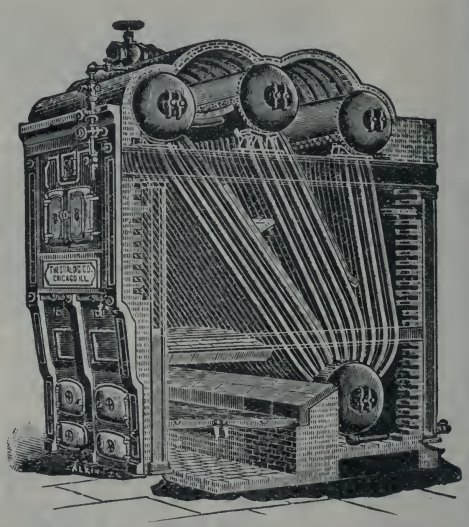

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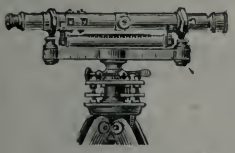

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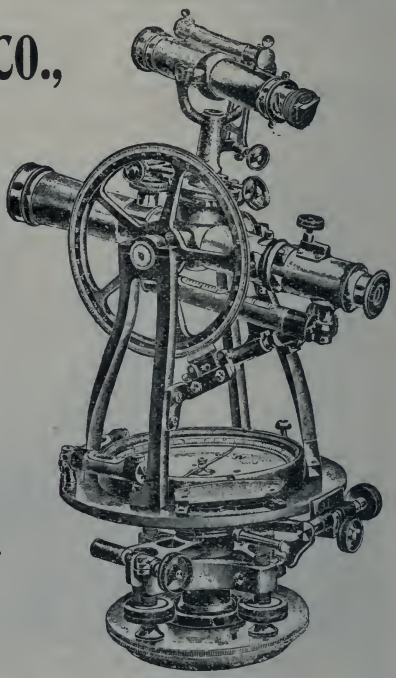

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CONTAINING THE

Proceedings of the Michigan Engineering Society for 1902

PUBLISHED BY THE SOCIETY

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1. On the Relation of Sewerage and Water Supply to the Public Health: H. E. RIGGS, Toledo, Ohio; F. F. ROGERS, Port Huron; GEORGE S. PIERSON, Kalamazoo.

2. On Forestry: F. E. SKEELS, Harrietta; J. J. HUBBELL, Manistee; A. J. TEED, Cadillac.

3. On Engineering Features of Municipal Work to be Protected by Ordinance: W. J. SHERMAN, Toledo; E. W. MUENSCHER, Manistee; J. J. GRANVILLE, Saginaw.

4. On Roads and Paving: GEORGE M. AMES and DORR SKEELS, Grand Rapids; E. W. MUENSCHER, Manistee.

5. On Questions in Land Surveying: F. HODGMAN, Climax; DORR SKEELS, Grand Rapids; D. J. ALBERTSON and E. STRONG, Kalamazoo.

6. On Advertising: A. L. HOLMES, Grand Rapids; CHARLES HOLMES, Saginaw; F. F. ROGERS, Port Huron.

7. Press: B. E. PARKS, Detroit; J. J. HUBBELL, Manistee; CHAS. S. SHELDON, Ann Arbor.

8. On Topographical Survey of the State: E. W. MUENSCHER, Manistee; H. K. VEDDER, Agricultural College; J. E. JOPLING, Ishpeming; E. S. WHEELER, Detroit; JOSEPH RIPLEY, Sault Ste. Marie; A. C. LANE, Lansing.

Michigan Engineering Society

Twenty-third Annual Convention, Held at Grand Rapids, Mich., Jan. 7, 8, and 9, 1902.

The Convention met in the City Council rooms, and was welcomed to the city by Mayor Perry. By an unfortunate accident, the stenographer's notes of the Convention were destroyed, rendering it impossible to give the Mayor's welcoming address, or any of the oral discussions of the Convention. The president responded to Mayor Perry's welcome in a few well-chosen words of thanks and appreciation, and then addressed the Convention as follows: —

PRESIDENT'S ANNUAL ADDRESS.

WM. B. SEARS.

Gentlemen of the Michigan Engineering Society:—

I wish to extend a kind greeting to all of my fellow-workers, and to those who lend their presence at this, our twenty-fourth annual Convention. I don't know whether to thank, or scold, the hard-headed, practical members of this Society for selecting me as their President. They all know my extreme diffidence, inability to stand on my legs and entertain an audience heretofore without breaking down, and yet they had the hardness (or, shall I say goodness?) of heart, to place me at the front in this business. Gentlemen, you made a bad mistake; you should have imitated the modern politician, who runs "the caucus," and puts up the ambitious man, who seeks the office and commands the shekels. All the offices heretofore held by your humble servant, have been thrust upon him, just like this one, and the only consolation I have in this case, is the promise of my good friend, Prof. M. E. Cooley, our genial and capable Vice-President, to take the helm when I desert the ship, and bring her safely into port. He is laughing at me now, just like

the other young and old boys in this rebellious school, but I'll laugh at them ere long.

I shall not attempt, gentlemen, on this occasion, to give a résumé of the past year's progress in Engineering in the State or nation; the field is a grand one, and would require the genius of the poet, artist, painter, inventor, and statesman. I must refer the ambitious and aspiring young man who would forge to the front, to the Engineering periodicals of the day, that cover our tables, and fill library shelves, and content myself with calling attention to a few of our future needs, to promote the advancement of the younger members, and the student just entering the field.

Some man who thought himself wise said: "Don't arrest progress by praising the past." I don't believe in that saying, because I have found that a little praise "now and then, is relished by the best of men," and even boys, who perform good acts and deeds, are often inspired to repeat them, until they become the guiding habits of life, by a little judicious praise timely bestowed. Sickness prevented my presence with you one year ago, but you made a *record,* and I have read it.

First.— I want to thank Prof. Chas. E. Greene, for that brief history of our Engineering Schools and Colleges, showing that Michigan (our Michigan) was among the first of the States to found an Engineering School, which was not the product of private beneficence. (See pages 3 and 4, Annual, 1901.)

Second. — I want to congratulate our retiring President, H. E. Riggs, for that eloquent and inspiring address, wherein he sets forth the advantages, to our young men, of a broad and liberal college education, supplemented by a technical training to fit them for their special work. If there are any young men here who have doubts about the utility of this course, take Mr. Riggs as a model, and *imitate his example.* When I was a boy, sitting in the old log schoolhouse, sixty years ago, learning readin', writin', and arithmetic, which I liked, and later a little grammar, which I did not like, because I had to memorize the whole book, the opportunities for gaining a scientific education were very limited indeed. Morse's telegraph was just coming into use, and we can now form some correct estimate as to the standard of education among the people at that date, when

our national law makers refused to adopt and use it for the benefit of "all the people," but allowed it to drift into the hands of speculators, until it has become one of the strongest and meanest monopolies in the country.

Third.— I want to thank the members of the committee that gave us suggestions as to Engineering features of municipal work to be protected by ordinance; that is a masterly report, and should be engraved in large letters on the walls of every council chamber in the State. It should be printed in pamphlet form, and circulated among the small towns and villages, to guard them against foolish and costly blunders in starting municipal work. In the proceedings of the Illinois Society for 1901, sixteenth Annual, page 149, the young men will find an interesting paper by Burton J. Ashley, entitled, "Some Experience in Designing a City," which conforms very nearly to the recommendations of our committee's report; *read it.*

Years ago, in Iowa and Michigan, in laying out additions to town plats, I fought for liberal-sized blocks, with alleys of ample width, but the selfish landowner *raised objections.* Alleys occupy space, and his object was to secure as many lots to the acre as possible, regardless of the future convenience and comfort of the rising generation.

Prof. H. K. Vedder, of the Agricultural College, at Lansing, asks for suggestions in behalf of the students of engineering in the technical schools, and what can *we do* to aid him in mapping out a course of study to better fit the young man for the practical duties of life? Mr. Wells suggests, as engineers have frequently to administer large business affairs, a course in common law, law of contracts, and bookkeeping, of which I fully approve; and Prof. J. B. Davis, who generally hits the nail *square on the head,* says: "Technical teachers should be professional practitioners." I say amen to this, and for the following reasons: When a boy in my teens, I took up the study of surveying under a graduate of Princeton College, Master Hobby, a gentleman who, on leaving school, studied law, and practiced the profession for some years; but lacking ability as an advocate, being an honest, diffident man, lacking in what we call *push and check,* and the disposition to find flaws in land titles and rob his patrons, he quit *stealing,* and became a teacher. He was a kind-

hearted, learned man, chock-full of language and poetry, but he knew less about surveying than his pupil. He couldn't chop wood, harness a horse, or mark out straight rows for planting corn, and I could do these things fairly well.

What do you suppose he did? — Like the young lady who taught grammar in those days, he set me to memorizing the book, Davies' Surveying. Now, gentlemen, you know that was a hard task; I grew weary, and began to think of playing hookey. Years ago, I read a story about John Quincy Adams, "the old man eloquent," who died in the harness at Washington. When a youth, his father set him to work studying Latin grammar; he did not like this, it was like ipecac; it made him sick. Very well, says the father, take this spade, come with me, and do some ditching. In the ditch he soiled his clothes, blistered his hands, grew hungry, weary, and soon agreed to quit the ditch, and resume the study of Latin grammar. Now all the professor has to do when his boys grow weary of technics, is this; viz., take them into the field, and set them to work taking levels, laying grades, ditching, laying tile, building fence, planting trees, gardens, flowers, testing cement, brick, steel, iron, stone, etc., and manipulating all the improved machines on the ground. Instead of doing these useful things which are restful, helpful, and invigorating to the civilized young man with a grain of common sense, too many of them, I fear, are smoking cigarettes, chatting with girls who are chewing gum, kicking a ball, kicking and stamping on each other, reading the latest news from Michigan's eleven, and making night hideous hurrahing for Michigan.

Some thirty-two years ago, two graduates from the engineering classes at Ann Arbor, came to me soliciting employment. They were farmers' sons, and had learned to work. One of them entered the army at eighteen years of age, fought in the late Civil War, and later worked his way through college. In less than two years' experience in the field, they developed into trained and valuable assistants, capable of taking charge of locating parties, and conducting surveys with skill and ability. They were superior to men of equal talents, who lacked the mathematical and technical training of the college, and why? — Because they did not look upon labor as degrading. If the pro-

fessor finds dullards in his engineering classes, unfit for civil, mechanical, or electrical engineers (and this he can find out in a month or two), advise them to turn their talents into some other channel; there is a niche, a peg, a place for them. "Give the boys a chance;" perhaps they will bring up in the saloon or the State Legislature.

There is too little attention paid to drawing in our schools. Good, skillful, artistic draughtsmen, who can turn off work with neatness and dispatch, are rare and hard to find. I have not been able to secure the services of more than half a dozen such men in the past thirty years, and four of them were foreigners — English, German, and Norwegians. The draughtsman does not command as much pay as all assistant engineers in the field, capable of handling a party of six to ten men, but a good one should receive at least $100 per month.

The greatest objection to the schools of the day, as I see it (perhaps I am wrong), is the hurried system of *cramming* everything into the heads of every pupil alike, regardless of taste, aptitude, strength, disposition, or size and capacity of brain. Pigmies and giants must all crawl through the same knot hole. The giant becomes disgusted and sore, held in check by pigmies, and these latter become discouraged, trying to keep step with him. There is some philosophy in these lines: —

> "In whate'er you sweat, indulge your taste,
> Some love the manly toils, the tennis some,
> And some the jovial dance.
> The toil you hate, fatigues you soon,
> Nor scarce improves your limbs."

I was much pleased with D. Farrand Henry's history of the old plank road system of Michigan, valuable in their day when we had timber to burn and give away, but leeches of late years, like many other corporations and combinations of capital that evade their just share of taxation. I must repeat a sentence or two. He says: "The average life of the eighty-eight roads operated at any one time, was twenty-seven years, and the paid-in capital was $2,040,180." "If the rate of taxation fixed in the general act of 1848, one per cent on the paid-in capital stock, had not been changed, and it is certainly a low rate as compared with

the tax assessed on other property, the amount of the tax would have been over $20,000 a year; or in twenty-seven years, $540,000, whereas the whole amount of taxes paid is only $22,516.91 during fifty years. How is that, gentlemen? Doesn't that remind you of three-cent fares and special legislation for the benefit of *the people?*

But I am drifting, gentlemen, and must leave that "old plank road," which Mark Twain said would have proved very good, easy, and comfortable if some unconscionable scoundrel had not now and then dropped a plank across it.

We skip much now that was good: Crystal Water, by Mr. Wells, which I must drink freely, and grow young again. The Available Water Power of Michigan, and Its Development, by Mr. Robert E. Horton, should be read and studied by all liberal-minded men who take an interest in the future growth and development of this State. He calls attention to work now going on at Sault Ste. Marie, and I was in hopes of having this fully illustrated and described by C. W. Baggott, C. E., at this meeting. Standpipes and Elevated Reservoirs, The Portland Cement Industry, Marls and Clays of Michigan, Suitable Streets for Small Towns, Report of Committee on Roads and Paving, Relation of Taxation to Forestry, Relation of Sewage to Water Supply, were all ably treated; but the people of the State do not, except in a very limited measure through our annual reports, derive any benefits from these suggestions and valuable papers.

Some weeks ago in visiting the home of our worthy and able Secretary, Mr. Frank Hodgman, I saw and learned much that pleased me, and increased my love, respect, and veneration for the man. He is not only a farmer, but a master among the surveyors of the State, a musician, a poet, and a painter. Now, gentlemen, it occurred to me that while he is serving the Society, we might supply him with competent aids to collate and put the cream of our proceedings, papers, and reports into a book that would bring the Society some revenue, and secure for us a larger circle of readers. A competent committee might be assigned to select the topics suitable for publication. This may be an idle suggestion, but in leaving our annual meetings, it has always occurred to me that the people of this State, at least, would be greatly benefited if they knew more about our transactions than leaks out through the public press and our annual reports.

ROADS AND PAVEMENTS.

These we tread daily, and are always timely topics for discussion. And for the people's highways, several of the States have devised ways and means, and entered upon the good work. The General Government is taking part; fully equipped trains with modern machinery, passing from State to State, holding meetings, and building samples of road; they create almost as much stir, excitement, and commotion as the shows of the deceased Barnum. If the people could be induced to part with their money, for good roads, as freely as they do for tobacco, beer, *base ball, whisky,* and the circus, we should all be happy and clean shod. "Old Ned" would give thanks, nipping the grass by the roadside, as his former master, without whip in hand, went spinning by on the velocipede, and the denizens of the smoky, dusty towns were taking an outing to catch a glimpse of sunshine, sniff pure air, gathering health, strength, and happiness, as they softly glide over the modern highway. But the money is wanting. "There's the rub," and the break that checks and retards the movement. How shall this be obtained? In looking over what has been done in other States, I believe the system adopted in New Jersey for the purposes of taxation is best; viz., the cost is divided into three portions: One tenth from the adjoining property; one third from the State; and the balance from the county. I hope all young members of this society, interested in the construction of roads and pavements, will subscribe for and read *Good Roads Magazine,* published by Emil Grossman and Brothers, 395 to 399 Broadway, New York (price, one dollar), and *Municipal Engineering.*

GOVERNMENT LABORATORY TESTS.

On this subject we quote from *Good Roads Magazine* for December: —

"As a result of laboratory experiments conducted by officers of the United States government, the Department of Agriculture expects soon to be in a position to vastly improve the methods and greatly reduce the cost of road construction throughout the country. The work that is now being done by the department is for the purpose of developing the physical and chemical properties

of the materials employed in road making. The engineering features have already been well established; the depth at which the base rocks should be placed has been determined, as well as the exact angle of the road, in order to insure drainage and protection. The department experts will now endeavor to pick out the rocks that are best adapted for surface covering.

"From the investigations thus far pursued with certain rocks used for macadam roads, it has been found that by judicious selection of materials, roads can be put down to last from five to ten times as long as those built under the old systems, without any additional expense in construction. A program of work has been outlined to cover the next two years, and in that time the department expects to furnish information to prospective road builders in every part of the country. The laboratory that has been established in connection with this work is very complete.

"William R. Page, who has charge of the newly established government laboratory, remarks: 'Much money is thrown away in road building because the nature of the material used for surfacing is not known. The surface of a road must be hard enough to resist the ordinary wear and tear of traffic, but should be composed of materials which, when reduced to a powder, have a certain cementing value that prevents the particles from being removed by wind and water. The character of the materials used in a road must also be adapted to the kind of traffic to which the road is to be subjected. A roadway constructed for the light carriage traffic of a city and its suburbs should be composed of quite different materials, laid down in a different manner, from a road over which heavily loaded wagons are to be drawn. The most certain and economical way of determining these matters is in the laboratory, where small quantities of material can be subjected to all the tests of friction and cementation to which they would be subjected if actually placed in a road for use.'"

BRICK PAVEMENTS.

This material is now extensively used, and has come to stay. And while I don't like it for residence streets and streets for miscellaneous business traffic, on account of the infernal noise created, it is well adapted to heavy and slow traffic. In the use and study of brick as a paving material, I think the Illinois

Society is in advance of Michigan. See paper by W. H. Tarrant, Illinois Annual for 1901, page 69. Mr. Tarrant explains in detail how to proceed, and insists on having the finished surface of the concrete parallel to the surface of the finished pavement. Now as I see the work performed, this is seldom done; it is neglected in part, because the engineer is too busy, careless, or lazy to set proper grades, and lacks an *honest, skillful* inspector on the ground to compel the contractor to work to these established grades. Where the finished concrete is humpy, and in waves, the sand cushion will vary from "O" to two inches in depth, and in six months after the brick are laid, these waves appear in the pavement. Now this is bad practice, gentlemen. It costs nothing but a little care and skillful supervision to stop it. Will you do it?

Further: Read Illinois Report, 1901, page 83, report of the committee on paving brick, tests, and specifications. I call your attention to this because they deem it important, and recommend "a standard method of conducting the rattler test." Uniformity of brick of the best grade and uniformity of testing, when the proper machinery and method of making these tests have been discovered, should be adopted, to protect the taxpayer against waste. The labor cost to the contractor is the same; for handling and distributing; it is the manufacturer that needs watching.

SEWAGE AND WATER SUPPLY.

Now we strike the most important topic of the times, to the denizens of the cities, towns, and villages of the State. It is more important to the resident of the town than good roads to the farmer, because, when he comes to town, he refuses to drink *our poor water,* filled with wigglers; he generally takes *beer and booze,* which makes him wiggle just a little bit you know, enough to make him happy, and it is only the poor horse that knows anything about the condition of the roads on the way home. We are not going to find any fault with the farmer, because we love him, and plowed in the same field with him years ago. We want to see the farmer mounted on an automobile mowing machine living in Edison's new cement house, or M. Henrivaux's glass house, and leaving old Dobbin or Ned at home when he

comes to town (the new town), paved with stone-glass, made perhaps at Saginaw, Michigan. Seeing his shadow reflected from the new pavement, he will quit *booze*, and become a dignified gentleman, willing to aid us in sending to the State legislature some broad-minded, clean, capable, honest men,— men who will not only reform our system of taxation (which is travesty on justice and common sense), but give us a State Board of Health and a Sanitary Engineer, with ample powers to prohibit, as soon as circumstances will permit, the pollution of any and all streams in the State by sewage and waste products that pollute water. Our friends, Rogers and Pierson, have landed in a septic tank, *and called for aid.* Can you invent any way to help them out? With the increase in population, and impoverishment of the land, sewage belongs on the farm, and, among civilized men, should not be dumped into lakes, rivers, or ponds.

Enough of the past, and what of the future, when the young engineer — mechanical, civil, electrical, hydraulic, and sanitary — looks forward with penetrating vision, and makes a mental survey of the field? Its vastness transcends the comprehension of the average mind. We have done little as yet but run over the field, "gobbled up," and, with improvident hands, wasted the bounties of nature. The renovator *must* take the place of the destroyer; intercept the rushing torrents as it descends from the mountain side; hold it in check by dams and reservoirs, to fructify the fields, and make glad the hearts of coming millions.

Think of the railroads half constructed and poorly equipped, to remodel and reconstruct to meet the wants of the future; of the Isthmian Canal; the giant subway project by the Pennsylvania Railway Company, at New York; electric roads and improved highways; cities to pave, sewer, light, and supply with pure water, gas, and heat; public buildings, parks, docks, bridges, warehouses to construct, farms to drain, and forests to grow. The harvest is ripe and abundant. Young man, will *you* fit yourself to garner the golden grain? Armed with sound bodies, sound characters, intelligence born of the best scientific training you can master; and in doing the work, strive to unlift and benefit your fellow-man.

ELECTRIC RAILWAYS.

W. J. SHERMAN.

The marvelous development of the Electric Railway is a source of never-ending wonder even to those who are actively engaged in the work.

The growth of local transportation facilities and the change in the character of same during the last decade are perhaps no more clearly illustrated than in the following table: —

	1890	1900
Cable railways	600 miles	400 miles
Horse "	6100 "	500 "
Electric "	2100 "	18000 "
Total	8800 "	18900 "

Many of us can remember the time when the sight of a slow-going mule or horse car excited our rapt attention and keenest admiration. They were few in number and the runs were short, but a ride for the small sum of a nickel was a real treat.

In the south the mule was the favorite power, and he was sometimes so small as to appear altogether out of proportion to the apparent bigness of the small car of the early day.

Throughout the sandy streets of the Southern coast cities, notably Galveston, his footpath was a twelve-inch plank in the center of the track, and the precision with which he trotted the strait and narrow way was an example for us of the human kind to emulate.

But his usefulness in this particular field of labor is gone forever, and the subtle electric fluid has now become the well-nigh universal power for street railway traction.

Sometimes we can but wonder if the innumerable transformations and attendant tremendous losses in power from the coal heap to the axle motor will not stimulate the wonderful inventive

genius of the age to the production of a more economical power, and whether the electric car has come to stay.

The avidity shown by capital in investing millions in electric-traction would indicate unbounded confidence in the permanency of the trolley, but the writer somehow has a feeling that there is something better coming, and that its introduction will destroy the utility of a considerable portion of the enormous investments now being made in the present favored scheme of local transportation.

In this connection and more plainly to illustrate the magnitude of the losses in power under the present system, we desire to call attention to an elaborate graphical exhibit which appeared in a recent issue of the *Street Railway Journal,* showing in detail the effect of the transformation of the heat units of one pound of coal from the furnace through the boiler, steampipes, engine, generator, transformer, transmission line, and car motor to the axle of the car.

From this exhibit we obtain the following results: —

Number of British Thermal Units in one pound of Coal, 13200.

Losses in	Per cent	B. T. U.	Total Losses	Available Units	Per cent
Boilers	28.0	3700	3700	9500	72.0
Steam transmission	3.4	450	4150	9050	68.6
Steam Engines	60.2	7945	12095	1105	8.4
Generators	1.1	150	12245	955	7.3
Electric transmission	1.8	240	12485	715	5.5
Equipment	1.9	255	12740	....	....
Net available power . .	....	....	....	460	3.6
	96.4				

NOTE.— These results are said to be the average of sixteen stations and three hundred and ten (310) equipment tests by Albert B. Herrick. Boiler 425 H.P., engine 600 H.P., Generators were two 200 K.W. each. Weight of car 24,000 pounds, equipped with two 12A' Westinghouse motors. Transmission line was one and three-fourths miles long.

An expert in mechanical engineering informs the writer that the boiler losses average about 25 per cent instead of 28 per cent,

as shown in the table, that generator losses average two per cent, and the net available power in a well-built station should range from four to four and one-half per cent.

Is not this remarkable showing enough to cause us to pause and wonder if some more economical adaptation of power is not in store for us in the early future?

Here is the opportunity of the lifetime for some inventive mechanical genius. How soon will he appear?

It is said that the steam turbine, which is now undergoing extensive scientific tests, promises a revolution in the first cost of power stations, and will materially reduce the capital investment and maintenance expenses, without, however, greatly affecting losses in heat units, but there has yet appeared no available data bearing on this most interesting subject.

So far we have referred only to the power losses.

Attending them are the losses incident to the maintenance of this complex system of power generation and application, and in addition to this, the investment in this portion of our railway plants seems to the writer out of all proportion to the cost of railway proper.

It is no uncommon thing for an interurban railway forty or fifty miles in length, and running through the gently rolling country of the middle West, to cost twenty to twenty-five thousand dollars per mile with only forty or fifty per cent chargeable to the railway proper.

To the writer such an investment, considering the inferior roadbeds being built in most instances, seems excessive where passenger earnings comprise such a large percentage of the total earnings.

It is a well-known fact that passenger earnings are not in themselves profitable to the steam railways save as they serve to stimulate the freight earnings, constituting as they do but about twenty to twenty-five per cent of the total earnings, and this at an average of about two and one-half cents per mile for fare as against one and one-quarter cents on the electric line.

But the trolley is popular, affording as it does such undreamed-of conveniences in transportation facilities.

The earnings are good, and growing better every day, and the returns on the investment seem entirely satisfactory to capital.

Most of the interurban lines have been in operation sufficiently long to determine what net earnings can be depended on. Many of the interurban roads are still in their infancy. The machinery is new, and the original paint on the cars is still in service. Ties are still sound, and rails have not yet begun to show signs of wear. Repairs are slight, and renewals have not begun to appear in the operating expenses.

These, too, are boom times. The people are prosperous, and, as they always are in such times, are generous in the expenditures for travel.

But a general depression will come. These good times cannot continue indefinitely, and the earnest and thoughtful manager must prepare himself for a struggle to pay his operating expenses and fixed charges on the watered bonds which are the usual product of periods of unusual prosperity.

But what can he do more than is being done at the present time? Is not the property being maintained at a high standard of efficiency? — Yes. Is not the service rendered the traveling public as good as the volume of traffic in sight will warrant? — We admit it. If such is the case, can anything be done to stimulate earnings, and enable the road to tide over a period of depression? To this we answer, Yes; there is something which can be done by almost every interurban line in the country which to-day is not being done, and that is to develop the freight traffic.

There is plenty of it, and it is only awaiting proper facilities to be diverted from the wagon and steam roads, chiefly the former, to the electric roads. It is profitable business, too. More so than the passenger business, and it is not a little surprising that it is receiving practically no attention on most of our interurban roads at the present time. But the roads are mostly new and the business is young, and doubtless most of the managers will shortly be giving the subject the attention it deserves.

Already a progressive inventor of a neighboring city has put on the market what he terms a "rail-wagon," an ingenious contrivance which runs equally well over the lanes of the farm, the pavements of our city streets, and the great steel thoroughfares which are so rapidly connecting every village and hamlet with the neighboring mart of trade.

Such a device enables the farmer to transport the products

of his fields in four- to six-ton lots cheaply and quickly to the market ten, twenty, or fifty miles away, where, without breaking bulk, it can be delivered to the jobber, retailer, or direct to the consumer, as his pleasure dictates.

The writer believes this source of earnings to be a splendid field for labor on the part of the thoughtful and progressive managers, and one to which they must give attention if they would preserve the integrity of their properties and protect the capital investment.

The work of building up a freight traffic will be greatly facilitated by means of the telephone, which just at this time is extending rapidly into practically all the rural districts, and putting the farmer in close touch with the neighboring markets, and the merchant in touch with the country store.

Within the limits of a brief paper on electric railways, the subject assigned to the writer for presentation before the Michigan Society of Engineers, it is quite impossible to attempt to cover the entire field. Volumes might be written and still not exhaust the subject, though it doubtless would the hearers.

Only a few side lights will be thrown on this interesting engineering canvas.

One of these is the effect of land values due to the electric railway. In olden times real estate within walking distance of our business centers was the choicest, the most desirable, and the highest priced. Then came the horse-car, and what was the result?

The low-priced property beyond the limits of the walking district began immediately to attract attention. Its price advanced, and choice residence property of earlier days was no longer in demand. But there was a limit to the development under the horse-car régime, and the limit was due to the slow speed of the car and the distance it could transport and return the business man during the noon hour, for every business man dined at home in those days.

Beyond the horse-car limits real-estate values were low, and the lands unsalable, save to farmers and the truck gardener. The horse-car, covering five or six miles per hour, was succeeded by the electric lines, running their cars within the city limits at from eight to ten miles per hour, and almost immediately the

radius of highest priced and choicest residence property increased materially, and all properties beyond were enhanced in value.

But the city electric lines were limited in their development to the confines of the city by charter restrictions, and farm lands lying beyond, though still near the city, could at best become no more valuable than for use as truck gardens, while property still farther away gave promise of remaining as unsalable as farm lands usually are.

But there was a bright future for these same lands, and it dawned with the advent of the interurban railway, which is to-day pushing out in all directions from practically every one of our large cities into and through these selfsame lands. And the effect on values,— what of it? — It makes farm lands five miles from the corporation nearly as valuable as those adjoining, eliminating, if you please, such lands as are prospectively valuable for platting purposes.

Before passing from this subject, it is interesting to note that the outward movement on the urban lines in America, due to uniform fares, is strangely in contrast with the massing of the people in the British cities, which the graded fares there prevailing does not relieve, much to the discomfort of the crowded population.

That the electric railway, particularly the interurban, is in a transition period is perhaps as apparent in the roadbed as in any other respect.

For the past ten years there has been comparatively little improvement in the standard of our trunk lines of steam railway. But what of the electric railway? At the beginning of the last decade there was hardly a high-grade street railway in the country, and the interurban of that day was satisfied with the cheapest kind of construction. Five years ago the standard was much higher, but still poor, and the singular feature was that practically no forces were allowed on maintenance.

To-day many of our roads are following the standard of the steam roads of perhaps ten years ago, and those managed by men of the longest experience in electric railways are almost invariably working to higher standards than those new at the business.

It is a well-demonstrated fact that those roads which are the best constructed and which are maintained in the most perfect condition physically are showing the largest per cent of net earnings on the investment, other things being equal. In other words, it pays to build well and maintain well, and high standards are profitable.

Since the preparation of this paper was begun, a prominent electric railroad engineer stated to the writer that one of the well-known syndicates engaged in extensive railway construction had very recently decided that they could not hope to construct and fully equip in accordance with a correct standard for much less than $40,000 per mile in the Middle West.

If this statement is true, it means a very much superior type of construction to any we have seen yet, and emphasizes very emphatically the point the writer is trying to establish; viz., that the electric railways to-day are still in their transition period.

To the employees this matters little; to the public it is interesting and welcome, but to the owners of securities in existing roads it may prove financially embarrassing to discard the old for the new unless earnings grow with a rapidity sufficient to take care of reconstruction expenses.

Up to the present time it is believed that this is generally true for the urban lines, and that in the change from horse to cable and then to the trolley the increased net earnings have provided for the increased investment; but the density of population along the urban lines, which provides good revenues from an extensive passenger business, is wanting along the interurban lines, and the latter therefore must look elsewhere for revenues sufficient to provide for the heavy investment. The writer believes the development of freight and express will do this.

We have some proof of this in a recent report of the Metropolitan Street Railway Company, from which we glean the following. Of three divisions of that road, one is operated by horses, one by cable, and one by the trolley, and the relative average earnings and expenses per car per mile for the years 1898, 1899, and 1900 were as follows: —

	Horse		Cable		Trolley	
	Cents	Per cent	Cents	Per cent	Cents	Per cent
Gross Earnings	36.29	100.0	34.90	100.0	30.25	100.0
Operating expenses	18.27	69.5	17.39	49.8	11.78	38.9
Net earnings	8.02	30.5	17.51	50.2	18.47	61.1

Notice the increased percentage of net earnings of the trolley over the cable and the cable over the horse cars. It is well to bear in mind that these percentages will apply only to operations under the most favorable circumstances, and that in the sparsely settled Western cities and suburban districts we cannot hope to obtain such results. Reliable data from the interurban lines is difficult to obtain, but in eight of the cities; viz., Louisville, Rochester, Buffalo, Detroit, New Orleans, Milwaukee, Toledo, and Worcester, the operating expenses average 58.2 per cent and the net earnings 41.8 per cent of the gross earnings.

One of the most radical departures from beaten paths in the line of electric traction which has developed during the year is the adoption of the trolley for canal-boat towage, as proposed by the Miami & Erie Canal Transportation Company. Believing that the plans of this company would interest the members, we have obtained from Chief Engineer F. A. Little the following outline of the work in which he is engaged: —

"After doing considerable preliminary work and investigating numerous systems of canal propulsion and towage, among which were several styles of side and stern-wheel propellers, towing with stationary chains, moving cables, aerial wire and track, and low-geared automobile, known as the Galliot & Denefle system, and electric railroad with single rail, upon which is operated a motor with the principal weight of same coming upon the drive wheels upon one rail, and the equilibrium maintained by the outer wheels running upon the towing path. This is the system known as the Kotten system, which is now used by the Persian government on the Finow Canal. The author of this system, however, has recommended the use of two rails instead of one.

"The objection to all propellers and side wheelers are that they wash the banks too much, and because of the small cross-section area of water in the canal, high speed has never been ob-

tained. The aerial wire and track was a complete failure. The Kotten system gives good success, but the loss through friction caused by having two wheels of the track running upon the towing path makes it advisable to use two rails.

"The two-rail system, or the standard railroad construction, was the one adopted by us as the more desirable system to use, and it is proposed to operate upon this track a mining type of electric locomotive with a cab placed upon same for the protection of the motorman.

"The work of construction for this system was commenced last July upon that division of the Miami & Erie Canal between Cincinnati and Dayton, a distance of sixty-six miles, and grading is now practically completed, and track laying has commenced.

"In order that the rights of the faithful mule may be fully protected, the ballast will be filled over the ties, so as to make a good roadway over which the mules can travel.

"A new departure in electrical equipment is being installed. Induction motors will be used in the electric locomotives. A three-phase alternating current will be used, with 4-0 trolley wires for two phases, and the rails will be used for common return. For the present, power for the use between Cincinnati and Dayton will be obtained from Cincinnati. The voltage of the current, as taken from the switchboards of the company that is furnishing the power, will be 4,500 volts, which will be carried to a point outside of the city limits of Cincinnati, and where it will be stepped-up to a voltage of 33,000, and fed into the high-tension feed-wires, which will consist of three 3-0 aluminum wires carried upon Loche insulators upon cross arms at the top of forty-foot poles. Every fourteen miles or oftener, if found necessary, substations will be installed containing static transformers which will reduce the voltage to 1,100 volts, which will be fed into the trolley wire. Upon each motor will be another transformer which will step-down the current to 250 volts, which is deemed sufficient for the slow speed of four miles per hour at which the motors are to run.

"The economy of this system of transmission and operation is, that it greatly reduces the cost of copper and reduces the cost of operation in that no machinery is required in the substation, and which will require only occasional inspection, and will also

save the loss in operation on account of the transformer heretofore required to change the alternating current to a direct current. While the use of induction motors is not new, the use of them in transportation work has not been tried to any great extent in this country. From experiments that have been made so far, electrical engineers are very confident that induction motors for electric railway service will soon replace the direct current motors now in use, the great economy being in the ability to use alternating current, transmitted long distances, at a high voltage, and the use of static transforming stations that require little or no attention. When induction motors have been perfected so that they will get into general use in the operation of interurban railways, many of the difficult problems that confront our engineers in the way of expensive power plants, upon which the interest and cost of operation eat up all the profits, will be solved. It is not improbable that many of the steam roads will then begin to consider electricity for motive power."

In concluding this somewhat rambling paper on Electric Railways, wherein we have not even attempted to cover the field, but simply have called attention to a few of the many interesting features of an intensely interesting subject, we have a word for the engineer to consider particularly as regards his relations to the capital investor.

How natural it is to overestimate the advantages and underestimate the obstacles to be overcome in the developments of a prosperous railway.

The engineer should inspire the confidence of capital by always being conservative. He should be thorough in his preliminary investigations, and be firmly convinced that an enterprise will pay before advising his principals to embark in it.

Confidence once established, the engineer will have no trouble in inducing capital to enter the field he recommends.

THE CORONA WATER SYSTEM.

A. L. REED.

In the beautiful Southland of California, where the valley of the Santa Ana River, midway from the mountains to the sea, broadens out into the sloping mesa to the south, and gradually narrows into the Temescal Cañon, lies the village of Corona, formerly known as South Riverside. Early in the eighties, these lands attracted the eye of enterprising men from the Eastern States, and their purchase and improvement began; and at present there are about 3,500 acres of bearing orange and lemon and other trees growing on the sloping mesa that was a short time ago the home of the coyote and jack rabbit, where the sage brush and poppy grew side by side. It is not of the place, but of the system, that supplies the life-giving water to these acres of orange and lemon groves that I wish to call your attention at this time.

Without artificial watering few trees or anything else grow in southern California; and to make a success of any improvement of lands, water must be provided. The original supply for the Corona colony was obtained from the Temescal Creek, a stream of small dimensions, flowing down Temescal Cañon. Soon more was needed than the stream supplied, and a pipe line was built some eight miles up the cañon, and some springs and mountain rills tapped. Thus also the evaporation and loss from seepage of the streams was saved. In 1891 another pipe line on a higher level was built, extending farther up the cañon to what is locally called the Temescal Basin, where the mountain waters gathered in a natural underground basin that was tapped by several artesian wells. This increased the supply, and answered for a few years more; but with the advent of dry years, the artesian wells ceased to flow, and recourse to pumping became necessary. This answered for a time, but as the basin was of limited area, and the seasons continued dry, the water level was rapidly lowered, and after two dry years, the supply was becoming exhausted.

In the emergency the water company went to the head of Temescal Cañon to Lake Elsinore, a small sheet of water nestled in the mountains, and began pumping from the lake and sending

the water down the cañon about twelve miles to the head of the pipe line. This was, of course, a wasteful and expensive proposition, and in addition to the expense and waste, the water from the lake was found to be so strongly alkaline that it was a serious menace to the life of the trees upon which it was used. The scheme had to be abandoned, and meanwhile pumping continued at the Temescal Basin. In the beginning of the year 1901 the surface of the water in the underground reservoir had been lowered to seventy feet below the surface of the ground, and was still rapidly lowering as the diameter of the basin decreased. The question, "What shall we do?" stared the colony in the face, and it came to this: Water we must have, or our valuable orange and lemon groves will be ruined, and we as well.

In this emergency there seemed but one thing to do, and to this they proceeded at once. Thirty miles to the southwest of the Temescal Basin lies the broad and fertile Perris valley. During recent years it has been discovered that there existed a large underground river, or stratum of water, which is supposed to be the underground flow from the snows and springs of the San Jacinto Mountains, to the eastward, old Grayback and its kindred peaks, where the rain and snow fall is comparatively heavy. The stream had been tapped in numerous places by wells, and in these wells the water stood within thirty to forty feet from the surface, and could not be exhausted by pumping. Briefly, the company's plan was this: to secure enough land above the underground river, put down wells, and pump the water to the surface, conveying it thence in pipes, cement conduits, inverted siphons, and flumes thirty miles to connect with the old system at Temescal.

There was only one practical route for the system, and that was as follows: from the wells nearly west for three miles across the Perris valley, thence southwest in a somewhat circuitous route along the cañon of the San Jacinto River to the border of Lake Elsinore, thence along the mesa at the edge of the lake through the village Elsinore, and down the Temescal Cañon to Temescal. The work was to consist of cemented open conduit, cement pipe, wood stave pipe, inverted siphons, and flumes. In such soil and location as practicable the cemented open conduit was used. This was made with various dimensions as the grade required. The side slopes were one to one, and the conduit trimmed to a true templet,

and then moistened and plastered one-half inch thick with cement mortar, mixed four parts of clean sharp sand to one part best imported Portland cement. The mortar was put on with a trowel, and carried six inches over the top edge. After setting, it was washed over with a coat of neat cement, and kept wet for ten days. This construction work, while not very substantial, was comparatively cheap, and prevented all seepage and cutting, giving quite satisfactory service.

In places where the open cemented conduit was impracticable, cement pipe was used, varying in size from twenty-six to thirty-six inches. The pipe was made of clean sand and gravel, three parts of sand and gravel to one of best Portland cement, thoroughly tamped in molds, and kept moist seven days from date of making. It was laid with joints of cement mortar made from two parts fine sand and one of cement. The joints were well filled and pipe laid true to line and grade.

Around rocky points and through depressions too wide for economical fluming were laid redwood stave pipe, in the form of inverted siphons. In some cases these siphons were several thousand feet long. These were made of two by six inch redwood, perfectly clear and beveled to exact curve and radius of the circle, banded with one-half inch steel rod bands with malleable iron clamps and adjusting nuts. The bands were spaced according to the pressure of the different heads required. All iron parts were dipped in hot asphalt and painted over with asphalt after being laid in place.

Over deep and narrow cañons where the inverted siphon was not practicable, flumes of redwood on pine trestles were built, the flumes being coated inside with hot asphalt after being caulked with oakum. Connections between pipes and flumes were made with cement boxes where practicable, but at the ends of the inverted siphons wood boxes were used so as to adjust themselves to any slight movement of the wood pipe when first filled with water. It was anticipated that there would be some slight buckling when the pipe was first wet and soaked. However there was little trouble on this score, and the wood box connection will after a time be replaced or lined with cement. The flumes were built of one and one-half inch selected redwood dressed on one side and bevel jointed so as to be caulked with oakum, and afterward coated with hot asphalt and made perfectly tight.

The contracts for the work were let in the latter part of March, 1901, and the entire work, with the exception of about four miles, where the old surface earthen ditch could be used temporarily, was completed ready for use by the last of July. The cost of construction was in round numbers, one hundred and fifty thousand dollars, with prices about as follows: —

30-inch cement pipe (made and laid), per lineal foot	$ 1 20
30-inch redwood stave pipe, per foot	1 40
Plastered open ditch a less less than 5 cents per square foot.	
Redwood lumber (in work), board measure, per thousand	45 00
Pine lumber (in work), per thousand	30 00

The cost of the Portland cement, which on the Pacific Coast is nearly all imported, was $3.65 per barrel, on the car at nearest railroad point. Gravel for some sections had to be shipped in by rail at a cost of about $1.75 per cubic yard. At other points it could be had for the cost of hauling. The distribution of the cement pipe from the yard where made was by team, and in places access to the line was somewhat difficult, making the hauling quite expensive.

The system is planned to carry eight hundred miner's inches, or in better terms, sixteen cubic feet per second, although much less than half that amount will supply the present needs of the Corona lands. The pumping from the wells is now done by electric power operating centrifugal pumps. I am unable at this time to give the exact cost of pumping as the engineer of whom I expected to get the data is sick and away.

The portion of the work with which I had to do as contractor was the lower section of eight miles, and it traversed some very rough country, the lower three miles especially being a succession of changes from pipe lines to flumes, inverted siphons, plastered conduit, and concrete work; and it is very interesting to follow the flow of the water and watch it now gliding along in the cemented conduit or flume with scarcely a ripple on its surface; so smoothly does it flow there into a pipe and through a tunnel, disappearing on one side of a deep cañon, and reappearing on the other bank as if nothing had happened, hurrying along, never at rest, but intent on reaching the groves at the end of its journey then to be divided and distributed to give life and vigor to the tree and fruit that shall gladden the homes of millions of people.

This system exemplifies what can be done by a few people who are united in their efforts. It remains, however, for the national government to assume charge in a larger and more complete way, and conserve the waters that now run to waste, and make them available for use on the arid and semiarid lands that are now of little value. The government is already awakening to the importance of a national irrigation system; and before many years shall pass, will have begun in a systematic way to do that which it only can accomplish,— the conserving and handling for the benefit of the arid lands, the mountain waters for the great Western plateau and valleys, lands now of so little use.

THE USE OF CONCRETE IN SEWER CONSTRUCTION.

HARRY V. GIFFORD.

It seems somewhat strange, when we consider the various and almost unlimited uses to which concrete has been put in both Europe and America; that it has not been more generally employed in sewers. Of course, its use in foundations and cradles has been extensive, but examples where the entire sewer has been built of concrete are comparatively few. In Brussels, Belgium, the storm flow of the Maelbeek Creek has been turned through a concrete sewer, varying in form to suit local conditions, from a circle with a 15 foot radius to a section 30 feet across and 9 feet high. In 1894 a sewer was built in New York of large concrete blocks. It was rectangular in cross-section with a foundation of piles and the top of steel beams and concrete. In Boston different forms have been used to fill certain local conditions. For instance, an inverted siphon was laid under Malden River, made of wooden staves, held together with steel straps on the outside, and lined on the inside with four inches of concrete.

At Washington concrete has been used more extensively than in any other city in this country. Their specifications call for monolithic concrete shells, from ten to thirteen inches in thickness, according to the diameter of the sewer. An arc of 120° on the bottom of the invert is lined with vitrified brick, and an arc of 30° on each side of this, with red brick. The top of the arch is covered with a Portland cement plaster three-eighths of an inch thick. In Reading, Pa., two miles of such sewer have been built varying from three to fourteen feet in diameter, but with the brick lining omitted. In Salt Lake City a gravity outlet sewer was built in 1894, between six and seven miles long, and varying in diameter from thirty-eight to sixty-four inches. The bottom two thirds of the circumference was a monolithic concrete shell of varying thickness; the top one third was arched with brick. These are but some of the examples in this country.

The concrete sewer constructed at Coldwater, Mich., last fall, by the speaker, as engineer in charge of construction, was unlike any of the concrete sewers just described, and yet was somewhat

similar to some of them. It was, as far as I know, the first one of its design ever built. The city of Coldwater has a population of 6,216, according to the census of 1900, and is built upon an exceedingly flat stretch of ground. The streets have never been properly graded, and very naturally some difficulty has been experienced in getting the surface water in time of storms to run in any particular direction.

Some fifteen years ago an eighteen inch tile sewer, if such it may be called, for it was built with "ring" joints without the ring and laid with a carpenter's level, was built for a trunk storm-water sewer, on Clay Street from Peckham Street to Coldwater River, a distance of some 1,600 feet. From year to year branch after branch has been added, regardless of size or anything else, except that it would furnish a temporary drainage for an individual's property.

The human race is not greatly advanced beyond the customs of its forefathers of the prehistoric ages, when it comes to the matter of disposing of one's refuse upon one's neighbor. The result of all these so-called improvements was that in time of storm the capacity of the trunk sewer was too small, and the backed-up water would rush in floods over sidewalks and lawns as if no sewers existed.

During the past summer the firm of Riggs & Sherman, of Toledo, was called in to design a new trunk sewer, and after looking over the ground they decided upon a circular sewer three and one-half feet in diameter. The subsoil which underlies about eighteen inches of hardpan is a loose gravel of excellent quality, very free from clay or organic impurities, and in limitless quantities; and some of the very best of American Portland cement could be obtained there for $1.35 a barrel, delivered on the work. These facts, together with some others, led the engineers to recommend a sewer built entirely of concrete. Bids were asked on three separate designs: first, brick; second, concrete; with the invert a monolith eight inches thick and semicircular in form, and the arch composed of eleven concrete blocks; third, concrete, built entirely of blocks. The detail plan of these blocks called for a length of twenty-four inches, the intrados to conform to the arc of the sewer, subtended by a cord five and three-fourths inches long, the extrados a cord eight inches long, the coursing joints

being, of course, eight inches through. The lowest bid was $3.40 per lineal foot for brick and $3.00 per lineal foot for concrete, with block arch and monolithic invert, the bids on complete concrete block, sewer being rejected. The bid was let for the concrete sewer at $3.00 per foot.

The work to prepare the blocks was started early in September. Some 8,500 were required, and in order to give them as much time as possible to set, the majority of this work was done before excavation on the trench was started. Molds were made of two-inch lumber, and lined with tin, and the four sides of the mold formed the extrados, intrados, and two ends of the block, the remaining two sides being open, and the whole held together by screws or wedge clamps. The molds were not at first lined with tin, but after a little use the concrete stuck to the sides when the mold was removed. We found that the tin entirely remedied this difficulty. The mold when put together, was laid upon a mold board 1x12x30 inches, re-enforced by cleats across the bottom. When the block was completed, the mold was carefully taken apart, and mold board and block were carried out and laid down upon a stretch of sand that had been leveled off to receive them. The block was left upon the board until, by careful handling, it could be removed without injuring it. The length of this time depended entirely upon the weather — sometimes twenty-four hours was sufficient, sometimes two days. After being removed from the board, it was laid upon the ground and allowed to remain there for three days, after which it was placed upon the pile. After the blocks were twenty-four hours old, they were watered several times each day for at least a week, and in all handling great care was exercised to protect the inside face. Very few blocks were broken, which was rather remarkable, considering their weight of ninety pounds each, and the green condition in which they were handled.

A gang of fourteen men were all that could be readily worked with the room we had at our disposal. Two men to screen gravel, four to mix concrete, four molders, three men to shift and water blocks, and one foreman. The work was done in a gravel pit owned by the city, and this materially reduced the cost of the blocks because of less expense attached to the handling of gravel. Another thing which worked great benefit to the contractor was

the fact that he did not have to pay for the gravel, but to offset this he afterward gave the city whatever gravel they needed, from the trench. With a little practice each molder could turn out 175 blocks a day. Each batch of concrete containing one-half barrel of cement would average eighteen blocks. This would make the cost of each block between eleven and twelve cents, figuring in eighty-five hundredths of a cent on each block for use of molds and mold boards which were entirely lost. It is my belief that it would have been more satisfactory had the blocks been eighteen inches long instead of twenty-four. Although a man can make a block twenty-four inches long about as quickly as one eighteen inches, and it is not necessary to handle as many blocks to build a given distance of arch, yet the greater rapidity and ease with which the smaller blocks can be handled and the decreased liability to break or chip them, would offset the advantages of the longer block, from the contractor's standpoint as well as that of the engineer.

The matter of mixing concrete has been so thoroughly thrashed out in engineering publications, and is undoubtedly so familar to all of you, that I shall only refer to it briefly. The gravel that we obtained from the bank was of an excellent quality, and very free from clay or other impurities. A stratum of pebbles from which all the sand had been washed, ran horizontally through the bank. These pebbles, when caved down and mixed with the gravel beneath, easily balanced whatever surplus of sand occurred in the other gravel. This was all screened through a riddle with meshes one inch apart. The concrete was mixed in the proportion of one part American Portland cement to six parts of gravel, the only point of interest in connection with the mixing being the proper amount of water. If too much water were used, the concrete would stick to the molds, and after the mold had been removed, would fall apart, or at least lose its proper shape. On the other hand, if not enough water were used, the outside, and especially the corners would dry out before the concrete had set. This made a crumbly block. We found the proper consistency to be such that when smartly struck with the back of a shovel, moisture would appear upon the surface, or such that, after being rammed in the mold, water appeared upon the sides of the block.

The material encountered in digging the trench was the same loose, clean gravel that we got from the pit, with the exception of the bottom foot or two, which, in some places was a sandy loam. Every foot had to be sheathed and thoroughly braced, and constant watch kept on the banks even then, for they would crack off in long stretches from three to five feet back of the sheathing. The horizontal method of sheathing was first used, and proved quite disastrous to the contractor, for in driving it down it greatly increased the natural tendencies of the banks to cave. It could not be as readily handled as the vertical form, and after the top part was removed, the banks would cave, making it impossible to get out the lower courses. In fact the method is ill adapted to the character of ground at Coldwater, and after we had started to use the vertical method, the work progressed much more rapidly and satisfactorily. With the exception of going under the main line and four side tracks of the Lake Shore Railroad, with a cut of fifteen feet, no particular difficulty was experienced in the excavation.

When the trenching had reached the approximate grade of the top of the invert, stakes were driven in the bottom about five or six feet apart, and in a line equal to the distance of the radius, plus the thickness of the shell, plus one-eighth inch each side of the center line, as determined by a plumb bob from lines on the surface. These stakes were driven to such a grade that the top of a 2 x 4 set edgewise upon them would be to the proper grade of the top of the invert. The invert was then excavated to approximately conform to the outside of the finished sewer, and was then made to conform exactly by a semicircular templet of the proper dimensions, drawn along the runners. Where gravel was found in the bottom, it was impossible to hold the shape exactly, but where loam was found, the excavation could be made perfectly true. Concrete was then thrown in, and with shovels and rammers was worked into approximate form without the use of molds. The only part that was difficult, was to get the inside shoulder on both sides to stand up square. This could be accomplished by holding a float or a board along the inside, filling in behind it with concrete and tamping it down. We tried the use of a form in making the invert, which was built very much like the center used for arches of brick sewers, except

that about one third of the center of the arc was left out. This form was about six feet in length, and was suspended in an inverted position from cross boards resting upon the runners. The bottom of the invert for about one third of the semicircle was made to approximate dimensions; the form was then set on the runners over this partially prepared spot, and concrete was filled in on both sides, between the outside of the form and the side of the trench, and thoroughly rammed. The form could then be lifted off and the invent trued up. This gave very good results, the only objection to it (and an objection which was great enough to cause its rejection) was that the form was too large and clumsy, and was in the way of the workmen. It could be used with success in a soil where the excavation could be prepared a number of feet ahead, so that the form could be drawn along as each section was completed, but in a soil as at Coldwater, where the placing of the concrete must closely follow the preparation for the invert, this form was in the way. Either method gave an approximate form to the concrete, which was trued up by means of a semicircular templet with a radius of twenty-one and one-half inches. This left the surface of the concrete one-half inch larger than the finished invert. While the concrete was yet green, a heavy coat of mortar, composed of one part of cement to two parts of sand, was roughly troweled on. This in turn was brought to its true dimensions by drawing along the runners a third semicircular templet with a twenty-one inch radius. This left the surface perfectly true, and both concrete and plaster of proper thickness. It resembled a concrete walk which had been finished with a float. We tried smoothing it down with a trowel, but when a templet was applied to a section thus treated, it was found to be so far from its true form that the practice was given up after the first day. When finished, it was much smoother and truer and offered less resistance to the flow of water than the invert of a brick sewer.

When the coat of plaster had become hard enough so that a man could walk upon it without injuring it, two tiers of blocks were laid up to a line upon each shoulder of the invert. The mortar was composed of one part of American Portland cement, two parts of sand, and one-fourth part of slacked lime plaster. The lime made the mortar so much richer and so much

better to work, and the joints were so much better laid, that it fully offset what little weakening effect it had, if any.

The form for the center was then put in place, and the rest of the arch built up, care being taken to break joints. As each section (about eight feet in length) was completed, a thin grout of equal parts of cement and sand was poured over the top, and worked into all the joints. Gravel was thrown upon each shoulder of the arch and tamped down, and the center moved ahead. In back-filling we tried to arrange to cover at least eighteen inches over the top of the arch, and let it stand for twenty-four hours, but in some cases where several feet of earth were filled in before the arch was twelve hours old, observations failed to disclose any dislocation of the arch blocks or injury to the invert.

The manholes were built of brick, commencing on top of the invert at each side, and were built upon and dovetailed into the arch. Pipe connections were made by setting one joint of pipe in place, and building the concrete around it as the work progressed. A bulkhead was built at the river with a concrete foundation two feet deep, three feet thick, fourteen feet long, the upper part being of rubble masonry, one end of which was dovetailed into the wing of an adjoining abutment. A coping was built of concrete four inches thick. In some catch-basins that were afterward built we made use of some of the surplus blocks. The excavation was made as usual, and a six-inch foundation of concrete was laid. Upon this twenty-five blocks were set upon end in a circle, every other one being a half block. On top of each half block a whole block was laid, then the brick work was started, building up the lower ones until level with the higher ones, and completing the catch-basin with ordinary brick work. This simply suggests one more use for concrete.

Some idea as to the degree of strength to which the sewer will ultimately attain may be shown by this small incident. We had occasion to cut a hole through the invert for a fifteen inch connection when the sewer was about a month old. The trench had been excavated to the bottom of the sewer on the outside, and two men provided with heavy cold chisels and hammers, one on the inside and one on the outside, occupied a day and a half in cutting the hole. To ascertain the tensile

strength of the concrete, the writer made some tests, in person, at the laboratory of the Michigan Portland Cement Co., with proportion of one part of cement taken from sacks, on the work, to six parts of sand. Four briquettes broken after twelve hours in air and twelve hours in steam, averaged 215 pounds, the maximum being 250 pounds. This accelerated steam test is, I believe, approximately equivalent to the seven-day test. We tried to test some of the blocks for cross-breaking strength, but were unable to get sufficient weight to break them. Two blocks were sent to the University of Michigan and, through the kindness of Professor Cooley, were broken there, one at 4,280 pounds and the other at 4,530 pounds.

In Washington it is the custom to pave the inverts of concrete sewers with vitrified brick, but it seems to be a question whether the ordinary wear in a storm-water sewer is so great that a half-inch coating of rich Portland cement plaster will not withstand it. Certainly, neater work can be done by omitting the brick. An objection which might be raised against the concrete sewer, would be that in places where manufacturing wastes get into the sewer, certain acids might have a disintegrating effect upon the concrete. That might be true in a combined system, but, even then, I think, could be remedied by coating the inside with tar or asphalt. The greatest objection would be that the cost would be greater than that for a brick sewer in certain localities, and sufficient data is not obtainable to state in what degree this objection would hold. In Wilmington, Del., a brick sewer was built on a stone cradle at a cost of $14.84 per foot. This sewer was afterward extended, built entirely of concrete, at a cost of $10.20 per foot, using crushed stone instead of gravel. The sewer at Coldwater was cheaper than a brick sewer would have been. In almost any locality gravel or crushed stone can be obtained without excessive cost, and almost any place east of the Mississippi, good cement can be obtained at a reasonable figure. And when we take into consideration the increasing strength and durability of concrete in the ground, it would seem that at no very distant date the brick sewer must look for a strong rival in the form of concrete.

METHODS OF CARRYING ON GOVERNMENT IMPROVEMENT OF THE CHANNELS OF THE GREAT LAKES, AND SOME COMMENTS ON WATER LEVELS.

C. Y. DIXON.

In this paper it is intended briefly to describe the methods usually employed in making improvements of the channels connecting the waters of the Great Lakes, having especial reference to the St. Mary's and Detroit Rivers; and also to mention some features of the problem of controlling the water levels of the lakes with the object of maintaining a practically constant depth in the improved channels.

The purpose for which the improvement of this waterway is made, by the United States, is that of cheapening transportation. The channels which are selected for improvement should therefore be those of least cost, even though they be not altogether in our own waters.

Preliminary to the actual work of excavation, surveys must be made in order to determine the desired location of the channel, and to make an estimate of the cost of the improvement. These surveys consist in taking soundings at regular intervals, and borings to determine the character of material to be removed. The distance between soundings is usually 10 feet along cross sections,— the cross sections being from 10 to 50 feet apart, depending upon the nature of the material and the unevenness of the bottom. In rock where there are liable to be abrupt changes in the contour of the bottom, the cross sections should be 10 feet apart; and in clay or sand where the bottom is more or less uniform, the cross sections should be from 20 to 50 feet apart. These surveys are preferably made on the ice, but if this is impracticable they are made from boats,— the boats being anchored in the desired positions. The locations of the channel lines, cross sections, soundings, and borings are determined by transit pointings from triangulation stations previously located,— the system of triangulation embracing the area to be improved.

The method of making the excavation is determined largely by the location and magnitude of the work. When the required depth may be secured by the removal of bowlders only, this is usually done by means of a derrick scow with diving outfit operated by hired labor. The bowlders are found by means of a bar of iron (about 25 feet long) suspended to the required depth from the side of the scow, and when found, the bowlders are chained by the diver and hoisted out by the derrick scow. This method is necessarily slow and very expensive in proportion to the amount of material removed, but it is much more effective for the purpose intended than operating a dredging plant.

When shoals of small extent are to be removed, scattered over an extended area where it is impracticable to make surveys to determine the character and amount of work to be done, the method usually adopted is that of hiring a dredging plant under contract,— the contractor to furnish and operate the plant at a stipulated price per hour of actual working time of the dredge dipper. The plant required to be furnished consists of one dredge, two or more dump scows, and one tug with power sufficient for the effective handling of the dredge and scows under the conditions prevailing in the vicinity of the work. When the money earned depends upon the time worked instead of the amount of material removed, the government frequently does not obtain more than about 75 per cent of the ordinary capacity of the plant, therefore contracts of this nature are not desirable. This method of letting contracts for excavation is adopted only for experimental purposes, or when it is impracticable to let a contract for a stipulated price per cubic yard.

When the area to be improved and the character of material to be removed may be definitely known, and the face of excavation is small (being that designated as scraping), the method usually adopted is that of letting a contract for the excavation at a stipulated price per cubic yard,— the material being measured in the scows. The chief objection to this method is that frequently in soft materials, there is the tendency on the part of the contractor or his men to excavate to a greater depth than is desired. As there is no immediate use for a well or deep pool in any part of the channel, this tendency has at times been

the cause of considerable friction between the contractor and the government's agents.

When the area to be improved and the character of material to be removed may be definitely known, and the face of excavation is two feet or more, the method which is preferred is that of letting a contract for the excavation at a stipulated price per cubic yard,— the material being measured in place. In contracts of this nature the stipulated price applies to all material above the required depth and within the required limits. In rock or bowlders, one half of the contract price is also usually paid for all material removed for the first two feet below the required depth, and in clay or soft material one-half price is paid for material removed from the first one foot below the required depth. No payment is made, however, for material removed outside of the specified area, nor for material removed from below the stipulated subgrade. Experience has shown that in order readily to obtain the required clear depth, the excavation should be made about two feet deeper in rock, and one foot deeper in clay or soft material. It is intended to make ample provision for the payment for all material which it is necessary to excavate below the required depth, although the contractor is not prevented from excavating as deep as he chooses. When at all practicable, this method has been found to be the most economical to the United States, and it also practically assures to the contractor the right to run his own plant, and to do the work in the way he thinks the best. Whether the excavation be made on the basis of scow measurement or bank measurement, monthly estimates during the progress of the work are made on the basis of scow measurement, and in the case of bank measurement, these estimates are corrected at least at the end of each season's work by surveys from which is computed the actual amount of material removed.

Whatever the nature of the contract the area improved is swept over by a raft or scow from which bars of iron are suspended to the required depth, and all projections are required to be removed before final payment is made. In making estimates of the cost of excavation, the price per cubic yard is regarded as a function of the character of the material, the manner of its distribution, and the location of the work. By the "location of the work,"

is meant the liability to hindrance from storms, endangering the plant, to collisions with passing vessels, and whether strong currents usually prevail in the vicinity of the work. The cost of performing work by a derrick scow with diving outfit varies greatly, but the usual cost of this work is from $5 to $7 per cubic yard. The prices which have recently prevailed for hiring a dredging plant furnished and operated by the contractor, are from $10 to $16 per hour of actual working time for the dredge dipper,— the variation in the prices being mainly due to the different capacities of the dredging plant. The prevailing prices for removing material by bank measurement are from 12 cents per cubic yard in the case of sand or clay, to $3 per cubic yard in the case of bedrock or bowlders.

The clearing of the channel of obstructions to the depth of 21 feet at the present high-water stage being assured, the problem is now being considered of maintaining a practically constant elevation of the water surface. The fluctuations of the water levels of the Great Lakes may be designated as those covering a period of years, those varying with the season, and those due to gales and violent wind storms. At the mouth of the Detroit River, the yearly fluctuations are from 1.5 to 2.5 feet, — a period of from three to five years elapsing between extreme high and low water; the seasonal fluctuations are about one foot,— extreme high water being in midsummer and extreme low water in the late fall or winter; the fluctuations due to storms vary greatly according to the direction and force of the wind,— the greatest fluctuation of which there is record in recent years being about 6 feet on September 12th, 1900. The fluctuations due to storms are, however, of short duration, and as soon as the cause of the disturbance is past, the water surface soon returns to its normal elevation.

At the present time, the least depth of water in the channel between Duluth and Buffalo is at the cut through the ledge of limestone, at Lime Kiln Crossing, Detroit River. At the stage of water prevailing during the summer months of 1901, the safe navigable depth at this place was about 18.5 feet and during the months of November and December, 1901, the safe navigable depth was about 17.5 feet. Contracts are now in force providing for clear depth of 21 feet, at the present high-water

stage. From the above, it is seen that the lower stages of water usually prevail in the late fall, at the time of year when navigation is most active, and few but those directly interested, realize the loss in carrying capacity of the lake fleet due to the lowering of the water level of but a few inches. The interests of the vast lake commerce demand permanent channels that will be nearly of a constant safe navigable depth, and if the water levels can be controlled so as to assure this, it is a project, the carrying out of which should not long be delayed.

It is only within very recent years that this question has claimed the attention its importance demands. A report was recently submitted by the United States Board of Engineers on Deep Water Ways, after a great deal of research and examination, having for its object the solution of this problem. This report is now being supplemented by new data obtained as the result of a more extended examination by the Engineering Department of the United States Army. The more important data which is obtained is that pertaining to evaporation and rain fall within the basin of the Great Lakes, the velocity and discharge of the connecting streams, and the direction and force of wind and the resulting stage of water. In this connection it may be stated that about eighteen automatic water gauge registers have been established, embracing the entire lake system.

Another feature which must to some extent effect the water levels, and must be considered, is the probable effect of the opening of the Drainage Canal at Chicago. It has often been claimed that the deepening of the channels by dredging operations is the chief cause for the lowering of the water levels of the upper lakes, but this is not true, at least not to a great extent. In making these improvements it is the aim to so distribute the material removed as not to change the total cross section of the stream, and, therefore, it cannot seriously affect the amount of the discharge. It will be readily seen that when everything is considered which affects the water surface, the problem of its control bcomes very much involved, and in order to obtain the desired solution, the data must be the most reliable, and extend over a considerable period of time in order to embrace all conditions.

It has been recommended by the Deep Water Way Com-

mission in their report recently published, that a dam be built at the head of the Niagara River, having for its object the raising of the water level of Lake Erie, with a resulting higher stage at the mouth of the Detroit River. The stage it is recommended to maintain is 574.5 feet above mean tide at New York, being about two feet higher than the present high-water stage. It is evident that the sudden changes in the water levels due to gales and violent storms cannot be avoided. Therefore, it seems that to maintain such an elevation of water surface, would, on account of the fluctuations due to storms, cause considerable damage to property along the low, marshy lands surrounding Lake Erie (which lands have been drained and improved), that its execution would involve a cost and introduce international complications which should be avoided. It seems feasible, however, to construct a dam which would maintain about the present high-water stage without this damage and the complication incident thereto. If this may be done, a practically constant stage of water will be assured throughout the entire season, and from year to year, which is the object desired. It is hoped and expected that the data now being obtained by the Engineering Department of the United States Army will lead to a practical solution of this problem, and that such a project as may be recommended will be speedily carried out.

CITY WATER SUPPLIES FROM RESERVOIRS FED BY LIMITED WATERSHEDS.

GEO. L. WELLS.

STORAGE reservoirs for collecting water from limited watersheds are not so numerous in the Central and Middle Western States as to be called common. It is the opinion of the writer that they could be more generally employed with decided advantage for collecting and storing water supplies for cities located near the summit or divides of the great watersheds, where streams are small and much influenced by rainfall, where ground waters contain too much lime or carry objectionable minerals, and in some cases of stream pollution, water from such a source might be used to a better advantage than to filter water from the polluted stream.

In selecting the watershed, a location as near as possible to the pumping station should be sought. The area should have a sparse population, and be such a one as will not be likely to be used for residence purposes. It should also have a surface large enough to collect sufficient water for a reasonable growth of the city. The nearer the watershed is located to the city, the smaller will be the cost of the water supply pipe, but it may be found cheaper to lay a supply pipe some distance out from town where land is cheap. It will be well to consider several locations for the watershed and reservoir not only for their sanitary and engineering values, but also for the effect such consideration will have on the prices placed on lands, when it becomes known that they are wanted for the special purposes of a water supply. It is good business prudence, too, to have options obtained quietly on all lands that are to be considered, to prevent inflation of values and to avoid the delays of litigation and condemnation proceedings.

On a watershed of limited area having a population ordinarily found in farming districts, a study of the problem will develop ways of disposing of drainage from houses and barnyards; by carrying it in open ditches or tile drains to points where it cannot

enter the supply pipe. It will be found that this can be done quite inexpensively in a great many cases. Because there will be but few problems of the kind to solve, limited areas of watershed become all the more desirable for a source of supply for potable water. If trouble is experienced in getting land owners to consent to such simple arrangements, boards of health can insist that the land owner shall not pollute the public water supply or streams tributary to it. The Legislature has authorized city councils to pass ordinances protecting water supplies from contamination for a distance of ten miles from the city limits.

Water gathered from such a watershed will be found quite soft and well adapted for manufacturing and domestic purposes. Some vegetable matter will be washed in by storm water, but hardly enough to be injurious or objectionable. Sedimentation will take place in the large body of water stored, so that by the time the water is used there is little probability of there being anything objectionable from any vegetable or organic matter that would reach the reservoir.

It will be better if the storage reservoir can be located on the watershed, as it will be easier to maintain a supervision over the watershed because of frequent visits of waterworks officials to the reservoir. Then if a resident keeper is employed at the reservoir, and goes over the watershed from time to time to see that drains are in order, and to observe if there is any carelessness in disposing of organic matter, it will have a beneficial sanitary effect. A keeper's patrols over the shed will be more frequent if the reservoir occupies a part of it.

The valley of a creek having a wide, flat, clay bottom and steep sides will be the most economical location for the storage reservoir. The wide, flat bottom will give a large storage capacity; the clay will supply the cheapest possible material for a dam and for a tight bottom and sides; and the steep sides will reduce shallow water storage to a minimum.

In the construction of the reservoir, one of the largest items of cost is the expense involved in removing the soil from the bottom and sides, and earth in the vicinity of buildings. As soil is so porous and contains so much organic matter, it is totally unfit for use in the construction of a dam, except that it can be used

to flatten out the outer slope of it, after the required amount of selected material has been placed in the embankment.

In such a location as has just been described, it will be found that it is much more difficult to make an approximate estimate of the amount of soil that must be removed, because the thickness of the soil is so much more uneven than on level ground. But, large as the cost of removal of the soil is, it cannot be neglected, for obvious sanitary reasons. If it is urged by interested people that such an expense seems needless, the engineer who values his reputation will not be influenced.

In removing the soil from a reservoir site in a glacial drift, most of the bowlders that were originally deposited in the drift which occupied the valley before it was washed away by the creek, will be found in the bottom of the valley, and buried in the soil. The quantity of bowlders is apt to be considerable. They will make the excavation of the soil somewhat more difficult than if they were not there, but they will be valuable for paving the inner slope of the dam, and in building the waste weir and gate-house. They can be deposited in piles at convenient places for use in such structures and at less cost than any stone could be purchased for. If such piles can be left to be washed by a few heavy rain storms, the stone will be well cleaned from clay and soil that stuck to them when they were picked up.

The bottom of the valley should be carefully examined for quicksand. If found, its extent and location must be carefully determined and great skill and experience employed in building near it.

Valleys worn out of seamy rock, such as shale or slate, may require considerable crosscutting at the ends of the dams into the sides of the valley, and these crosscuttings filled with good clay puddle or concrete, to prevent seepage or leaks. Such valleys are apt to be narrow, and not afford storage at so low a cost as a reservoir located in a valley in a glacial drift or on a plain. Another objection to a valley in shale in the subcarboniferous formation, is that some shales carry a small amount of petroleum, which would give water stored in it a bad taste and odor. The writer has found some of these shales give off the odor readily when broken or struck with a tool.

In the Central States, as stated above, it will be difficult to

find a cheaper and more satisfactory material for the dam than clay. A great deal has been written about earthen dams, but a short discussion will be ventured here. As yet no one has ventured a formula for the construction of an earthen dam as has been done in the case of masonry dams. The engineer must use his judgment, the vast experience of others, and empirical rules to determine the shape and size of the dam. If a clayey gravel can be found, or if a near-by deposit of gravel or good sharp sand exists to be puddled with clay, a better dam will be built than if clay alone is used.

In constructing a clay dam a great deal is claimed for the use of a grooved roller, especially by the makers, who claim that the grooved roller will form grooves in each layer of material deposited which will prevent the formation of seams through which stored water would seep when the dam comes to do its work. This claim for the grooves formed by the roller is all bosh. The grooved roller is the best thing that can be used for compacting the clay, but if each layer is rolled as thoroughly as it should be with a grooved roller, when the rolling is completed, the surface of each layer will be about as smooth as a floor. If left in this condition, it will not require a very vivid imagination to see how water would follow such seams between layers. A grooved roller will have approximately twenty per cent of the length of the roller that will tread on a plane; hence, when it passes over the layers the last few times, there is as much pressure on the surface of the material that it comes in contact with as would be produced by a cylindrical roller of the same length having five times its weight. A five-ton roller can be readily handled by two very heavy horses or by three or four horses commonly used on public works, while a twenty-five-ton roller is practically useless on account of its great weight.

The following has been the practice and experience of the writer in constructing an earthen dam: The site is first cleared of all soil, and trenches dug or furrows plowed into the clay bottom, and well watered before depositing the clay filling. The clay is brought on and deposited in layers about six inches thick, then rolled with the grooved roller until the surface is smooth and hard. Furrows about eight feet apart are then plowed through the rolled layer. For this purpose a heavy contractors' plow with

four horses is needed. A sprinkling wagon then wets the whole surface of the rolled layer, and fills the furrows with water. It is found that the next filling quickly absorbs the water. If properly managed, the rolled surface can be made wet enough to destroy the seam that would be formed if left as the roller left it, and still not made wet enough to be sloppy or swell the clay too much. In windy or hot weather this water drys off more rapidly than the engineer would wish, so that it requires constant and intelligent inspection. The amount of water should be enough to form a good stiff clay puddle, but not enough to form mud. If all the details of this work have been properly looked after, the plow will throw out stiff, waxy clay puddle that will be proof of the thoroughness of the work. In this way the entire dam becomes one mass of puddle without the use of pug mills or hand work, and the whole dam is homogeneous, which would not be the case if a clay puddle or concrete core wall was attempted.

The inner slope should be paved with stone over its entire surface to prevent washing by the action of waves. Water in such a reservoir will stand at so many different elevations that this is needed. If enough bowlders and small field stones have been collected during the removal of the soil, the cheapest possible paving material can be used. If not, then quarry spalls can be used.

The outer slope of the dam should be seeded and a good sod maintained to protect it from erosion from rain water.

The dam should be provided with a waste weir of sufficient length to insure safety to the dam from the heaviest rainfalls. A careful computation made by the writer for a weir for a reservoir dam supplied by a clay watershed showed the safety of the old "rule of thumb"—"3 feet of length of weir for each 100 acres of watershed." As the wing walls are the same in any case a few extra feet of length of waste weir does not add much to the cost, and adds safety in case of cloud bursts.

The gatehouse is a very important part of a reservoir. It should be located either in the dam itself or in the sides of the valley, near the end of the dam with trenches cut though for the supply pipe. If located in the reservoir where it is exposed to the action of ice, damage will result.

Inlet pipes should be placed about two and one-half feet

centers in elevation so that water can be taken from the level having water of the best quality. All valves should have stems extending above the floor, so that they can be readily opened and closed by the keeper. There should be a substantial building for the superstructure of the gatehouse to prevent any interference of the valves by unauthorized persons. In addition to the supply pipe, leading from the gatehouse to the pumping station, there should be an independent pipe of larger size to use in case it is desired to empty the reservoir in a short time.

It should be remarked that no dam greater than a depth of fifty feet will be needed in the Central or Middle Western States.

In this region, too, few locations will be found at such an elevation that the storage reservoir will produce enough pressure to supply the distributing system by gravitation, but in most cases the reservoir can be located above the pumps, so a small economy can be realized by connecting the suction pipe to the supply pipe.

When a suitable valley of a creek cannot be found, the reservoir can be located at a convenient point on a plain, but the site for the reservoir should be one where the sudden swelling of streams by freshets will not endanger the reservoir embankments.

If such a location is selected, it will require a larger pipe between the watershed and the reservoir than would be required between the reservoir and the pumping station, because it is storms that furnish the bulk of the water for storage. This extra cost for pipe will emphasize the wisdom of locating the reservoir on the watershed.

The following "yardsticks" will help an engineer when making a reconnoissance to estimate for yield of the watershed, storage capacity of the reservoir, and the cost of removing soil: —

Thirty-seven inches of water flooding one acre equals 1,000,000 gallons. One foot of earth on one acre equals 1,614 cubic yards of excavation.

The cost of a reservoir of the kind here discussed lies somewhere between $400 and $700 for each 1,000,000 gallons of storage capacity. Cost varies greatly with the prices that have to be paid for labor, length of haul, etc.

At Bucyrus, Ohio, a reservoir storing 155,000,000 gallons of water, supplied by a watershed of 2,400 acres, was completed in

1900, under supervision of the writer and on plans prepared by him. Prior to that time the Sandusky River had been the source of supply. This river is one that is greatly influenced by rainfall. Immediately after a dashing rain the river overflows its banks with water so roiled that many residents call it liquid mud. In the summer, or during a period when there is not much rainfall, the water in the river is very low. Many times during the history of the works the pumps took the entire flow, leaving the bed of the river below the works entirely dry. During the season of high water a set of the best mechanical filters failed to take out all the clay, and the water went to the consumer in a highly roiled state. When the water in the river was low, the pressure was dropped to about twelve pounds, and all such services as lawn and street sprinkling forbidden. At all times the quality of the water was doubtful. Only a few families drank the water, and then after it had been boiled.

The city is located at the summit of the watersheds — one sloping toward the Ohio River and the other toward Lake Erie. One house in the town contributes to both the Mississippi and St. Lawrence systems. It will readily be seen that there is not much country to contribute water to the Sandusky River, or for supplying the region with large quantities of ground water.

They have just passed through one full year's use of the reservoir, and even during the dryest season have had an abundance of clear water of a superior quality. The litigation between the city and water company has been dropped, the citizens are satisfied, and the company making money, with good prospects of making more.

This is mentioned as a practical benefit of the water supplies discussed in this paper.

BACKWATER AND FLOWAGE.

ROBERT E. HORTON.

Streams of the Central States, flowing as they do over beds of glacial drift and alluvial deposits, have uniform, moderate fall. If dams are constructed they will, as a rule, back water over relatively long stretches. This is particularly true in the lower peninsula of Michigan, which is drained for the most part by long streams having their headwaters in the central plateaus at an elevation of 300 to 500 feet above the Great Lakes. The larger Michigan rivers seldom have, therefore, a fall exceeding 10 feet per mile. Their average fall is usually from 3 to 5 feet per mile.

As a result of recent advances in electrical power transmission, dams and power plants are being installed at frequent intervals on streams in favorable localities, so frequent, in fact, that it sometimes happens that flowage, or backwater, from one dam extends to the top of the next dam above. The mistake is not uncommonly made by those desiring to construct dams, of assuming that if the topographical elevation of the high-water mark on their dam when constructed does not exceed that of the natural water surface at the foot of the dam of the next mill above, the up-stream owner will suffer no injury from backwater. As a matter of fact, the water in a long, narrow pond is not at a "dead level," but curves upward, so to speak, to meet the sloping surface of the incoming stream from above.

Such of the laws and phenomena of backwater as can be stated now mathematically, are here given, and some principles stated which have been of use to the writer in treating backwater problems in practice. Perhaps the only claim to originality in the paper is that the use of higher mathematics is avoided.

If a dam is built at the foot of a broad lake, it is commonly understood that all lands in the lake basin lying below the level of the high-water mark at the dam will be flooded. The difference between the area of original lake surface and the new lake surface will be the "flowage," and the flowage will be bounded by an irregular line, or contour, called the "flow line," which is

at all places at the same elevation as the high-water mark at the dam. If, however, the dam be built in a river channel or gorge forming a long, narrow pond, into the upper end of which the stream flows, the form and position of the flow line, with reference to the elevation of water at the dam, may be somewhat modified. The effect being, that the water in the upper portion of the pond may stand at a higher level than that at the dam. The flowage will then extend back farther, and flood a larger area, than in the case of the still-water lake first mentioned, and the flow line will not follow the contour, or be precisely level. The difference between the flowage for a quiet lake, and one receiving a large stream, is termed "backwater," or more properly, "back-piling," because the word "backwater" is often applied to designate pondage due to a dam or any other cause.

A mill-pond which receives the waters of a running stream and discharges an equal volume of flow at its foot, represents an intermediate condition between a closed reservoir, or lake, and a running stream. When there is back-piling, it resembles the stream in that it has a surface slope.

The depth of flowage due to back-piling, as compared with that produced by the dam itself, is usually small. Its presence is often hard to detect, and its amount difficult to measure. The causes of back-piling are well understood. It is due in part to the inertia of the flowing water, and in part to fluid friction, or the viscosity of the water; and is therefore chiefly dependent on the velocity or slope of the inflowing stream.

The precise laws governing its formation are, however, very subtle. They have been investigated by the ablest hydraulicians with the aid of powerful methods of analysis, and even yet they can only be expressed mathematically in terms of transcendental functions. Some of the effects may readily be illustrated. For simplicity we may consider a straight, narrow stream of uniform width, depth, slope, and velocity throughout, flowing, we will say, in a deep, narrow gorge. The effect of building a dam in an idealized stream like this can be readily calculated. Such a stream would seldom be found in nature, but the phenomena we are considering will differ only quantitatively from those produced in a natural river. In the accompanying illustrations, the slope of the stream, as well as the effects of backwater and back-piling, are shown greatly exaggerated.

First, the considerations governing the building of a dam below an existing one may be considered, disregarding for the present the effect of back-piling. For illustration, we may consider two contiguous riparian owners on the same stream. The upper one B, already has a dam and mill, and A proposes to erect one lower down on the stream. We will seek to determine the height to which A's dam may be raised without backing water on to the property of his neighbor, B. Referring to Fig. 1, the lower dotted line represents the natural low-water surface; the upper dotted line, the high-water mark before building a dam at A. With water at the crest line, the dam at A would form a pond extending back to p. This does not in any way interfere with the head at mill B, a short distance up-stream. In extreme high-water, the level in the natural stream channel would be raised, we will say, four feet, or to the upper dotted line. The height to which the water on the dam will be raised will depend on the capacity of the spillway of A. Suppose the spillway is of such capacity that the water on the dam is also raised four feet. In that case, backwater will extend to t, or no farther than before. If the capacity of the spillway of the dam at A were further increased, the depth of high-water flow over the dam would be less, and the depth in the natural channel remaining the same, high water would not back up-stream as far as low water from the narrower spillway. Similarly, had the capacity of the original spillway been diminished instead of increased, high water might rise to the height r, seriously interfering with the effective head at dam B. Whether or not a dam at B will be troubled by backwater from A, depends both on the height of the dam at A, and on the capacity of its spillway.

Suppose that during low water the dam at A flows back nearly, but not quite, to B. If an increase in the natural depth in the river channel at B produces a like increase in depth of flow over the dam, the head of the pond will not vary up or down stream. If the rise at B is accompanied by a greater increase in depth on the dam, the point p will move back as the flow increases, and may obstruct the tail-race at B. The exact relation between the rise in the natural channel and the corresponding rise on the dam, depends on a complexity of conditions, and can be determined from a careful survey. The discharges in

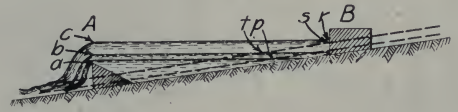


Fig. 1.

Fig. 2.

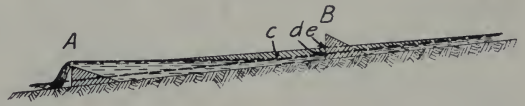


Fig. 3.

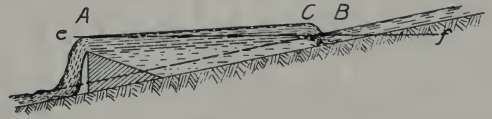


Fig. 4.

open channels and over dams are both functions of the depth, the discharge over a dam varying nearly as the three-halves power of the head, or as the product of the head by its own square root. The discharge in a river channel may vary more or less rapidly with the head, according to the form and condition of the stream channel. For rivers which remain of uniform width at all stages, it will, like the flow over a dam, vary nearly as the three-halves power of the head. Assuming that it is precisely so, we will usually be on the safe side. If the spillway be such that during low water a depth of one foot in the channel produces a depth of two feet on the dam, and the crest of the dam stands slightly more than two feet below low-water mark at dam B, then it may be shown that an increase of depth in the natural stream channel to two feet will correspond to an increase in the depth on the dam of four feet. The natural rise in the mill channel at dam B being one foot, and the rise on the dam A two feet; the water wheels at B will be obstructed by high water, but not at all during low water.

If now, the length of the spillway A had been such that a depth of one foot in the natural channel only produced a depth of six inches on A, then the dam at A might be increased in height one and one-half feet without backing water to dam B during low water. Again, if a rise in the stream to two feet depth occurred, the depth on dam A would only be increased from six inches to one foot. The water at B has raised naturally one foot, backwater from the dam will therefore be about six inches below the tail water level at B. Now in order that the low-water flow of the stream should produce a head of six inches instead of two feet on the dam at A, the length of spillway of A would have to be increased in the ratio of the three-halves power of the head. This would require that the capacity of the spillway should be eight times as great in the latter as in the former case. This is perhaps an extreme case, and yet it is not uncommon to find dams across flat valleys in which the length of spillway is not more than one half, one fourth, or even one eighth that of the dam, and where a much greater length of spillway could have been made for slight additional expense.

The above case illustrates the source of the ordinary backwater litigation, due to the capacity of spillways at the lower

dam being insufficient to prevent the rise on the crest due to high water, from exceeding the rise in the river channel above the pond. Thus it often happens that the head at the upper mill is seriously reduced by flowage from below during high water when the head is naturally the lowest, and is entirely free from obstruction by backwater at ordinary or low stages of the stream. The ordinary remedy is to force mill A to lower its dam. In the above case, with the shorter spillway the crest of the dam at A would have to stand at least two feet below low-water mark at B, and there would be a proportional fall wasted between the two dams during low water. The better remedy is to increase the capacity of A's spillway.

Referring to Fig. 2, the line a c, or distance up-stream to which flowage from dam A would reach if there were no back piling, is termed the "hydrostatic amplitude." The water in the channel above c has its velocity checked by dead water in the mill-pond as it approaches c. The energy due to its velocity of flow V, is, in part, utilized to lift the water above its normal level, both in the pond and for some distance up-stream. The greatest lift, or back-piling, occurs at C, and the amount diminishes as we pass up-stream. Just above the dam A, the water is at the hydrostatic level. The result is that the surface of the water is formed into a smooth, curved surface, as shown.

Back-piling is a fruitful source of contention among neighboring power users. In Fig. 3, the lower dotted line represents high water in the original stream channel. a c is the hydrostatic limit, and the upper curved line shows the actual surface of the water after the dam A is built. The elevation of high water at A falls below B's lower property line, and flowage from a still lake replacing A's mill-pond would extend only to c. As a result of back-piling, water at B's dam rises to e, or an amount d e, greater than the high-water mark before A's dam was built. A mill at any other point than B above A's pond would be injured during high water by an amount proportional to the depth of the shaded portion of Fig. 3. The contention in court usually hinges on the amount of back-piling d e. This is very difficult to measure, because it is usually small, less than one foot; and second, because the slope and stage of a stream are almost constantly changing, and a series of observations at both A and B,

extending over a considerable period of time, would be required to determine the true difference of level between water at A and at B. Even then, the question arises whether the back-piling at B is not due as a whole or in part to ordinary backwater from some obstruction or construction in the stream channel above c. To decide this point the water is sometimes drawn off through openings in A's dam to its original level; and the stage of the stream at B's lower line compared with the observed stage when the dam was full. To make this comparison of any value, the volume of discharge of the stream under both conditions must be measured, and the stages for equal discharges with and without the dam, compared. Even then the evidence is not conclusive, since, if the dam at A has been built for some time, a bar of sediment or detritus may have been deposited at C, where the velocity of the inflowing water is checked by its contact with slack water in the pond. Such an obstruction would tend to raise the water at B, with the pond drawn off, and to minify the effect of back-piling from dam A.

The amount of back-piling that would probably result from building a dam at A may be calculated. Parties proposing to build a dam where there is danger of interfering with an upstream mill through backwater, should by all means have this done, in connection with the determination of the permissible height of the dam. To make the result of such a calculation reliable, requires beforehand that a survey of the river shall have been made between the two dams, and that the high-water flow and stage of the stream shall be known.

If a mill is to be built at A, the proper course for a mill owner B to pursue, if he fears injury from backwater, is as follows: First, to keep a record of the elevation of the water at the lower line of his property before the dam A is built. These levels should be referred to some permanent bench mark, and measurements of the volume of flow at different stages should be made. After the dam at A is built, a second similar series of observations and discharge measurements will show whether or not the stage of the river corresponding to a given volume of discharge is higher than before; if so, the increase may safely be attributed to backwater, or back-piling, from the dam at A.

The depth or amount of back-piling d e, Fig. 3, in a given case, will depend largely on the slope, or rate of fall, and the character of the stream bed. If the slope is very great, exceeding, say, fifteen or twenty feet per mile, a peculiar condition occurs, in which the back-piling, instead of extending indefinitely up-stream, suddenly terminates in what is called a "standing wave," or "hydraulic jump," at the upper end of the pond, as shown in Fig. 4. Slope and velocity sufficient to produce a standing wave at the head of a mill-pond will seldom be found except in streams having rock beds; and for such the channel is usually so rough that the wave is obliterated.

The phenomenon of a standing wave is of common occurrence wherever the velocity of rapidly flowing water is checked on entering quiet water. It may be observed at the foot of a sloping apron of a dam during high water, or at the down-stream side of a bridge, the piers of which obstruct the channel considerably. In such cases it is often called a ressault or a remou. In the case of the ressault below a dam the sloping apron corresponds to the steep river channel described above.

Any obstruction or diminution in the area of section of a stream produces backwater, and often also back-piling. The most common cases are the construction of bridge piers, narrowing the channel for the reclamation of land, and the building of railway or highway embankments which encroach on the stream channel, the amount of injury resulting from backwater in such cases being in some degree proportional to the ratio of the area of the original clear waterway to that of the obstructed channel. During high water, when a dam becomes submerged or drowned, a standing wave is often formed just below the crest, and this is the only evidence on the surface of the existence of the dam.

Rifts, or riffles, are standing waves produced where water flowing over bowlders or other stream bed obstructions, strikes water below.

Where two lakes at nearly the same level are connected by a short channel, the rate of outflow from the upper to the lower will be governed by the slope of the water surface of the connecting channel. If a dam be built at the foot of the lower lake, the fall between the two will be diminished, and the capacity of the outlet of the upper lake decreased; the result will be an

increase in the level of the upper lake until the discharging capacity of the outlet is restored to its former amount. In this way a dam at the foot of the lowest lake of a chain may raise the levels of the lakes above through back-piling, though not greatly diminishing the fall between them.

DOWAGIAC RIVER IMPROVEMENT.

W. H. GOSS.

The Dowagiac River is a tributary of the St. Joseph River. It rises in the eastern part of Decatur Township, Township 4 South, Range 14 West, in Van Buren County, and flows in a southwesterly direction, emptying into the St. Joseph at Niles, in Berrien County, in Township 7 South, Range 17 West.

From its source to its mouth it is about twenty-five miles on an air line; to follow the windings of the channel it is at least three times that distance.

The watershed covers the greater part of eight townships, and comprises sandhills and tablelands that need little drainage, and a swampy flat from one to two miles wide, through which the river flows. This swamp does not extend the whole length of the river, but only about two thirds of the length from the upper end.

The lower course of the river runs through a hilly country, with but little swamp. This swampy flat, which was originally quite wet, has been made still wetter by drains from the higher elevations dumping water down onto it. This low land is very fertile, but has never been improved to any great extent, owing to a lack of adequate drainage.

The first attempt to drain a portion of this swamp was made about twenty-five years ago, when the land owners, aided by the State Board of Public Improvements, undertook to drain the upper part of this swamp by straightening and deepening the river from a point near its source to the south line of Van Buren County, a distance of about six miles. This took the water from the extreme upper end of the swamp, but made it wetter along the lower course of the drain. It simply made it drier on one part of the swamp and wetter on another.

This was for want of a suitable outlet, and it is needless to say that the lower course of this drain soon became clogged with silt and weeds.

Within the last few years the question of extending this drain through the swamp to a suitable outlet has been thoroughly

agitated, and this agitation has resulted in the drawing of a petition to straighten, clean out, and deepen the river, from the lower end of the State drain through the swamp, and as much farther as necessary to procure a suitable drainage for the entire swamp.

As I have had charge of the laying out of this work, I will describe it to you as best I can. The first thing that was done was to make a reconnoissance of the entire route of the proposed drain. I found the river channel very crooked and tortuous. Some parts of it, however, were comparatively straight, and ran in the right direction, so that they might be used to advantage.

At other places the river would turn back and forth across the valley in a way that was bewildering. In many places the channel was choked with fallen timber. Much of the route lay through the forest. Some levels were taken to ascertain the general grade of the water. I located the channel most of the way, marking trees where it seemed advisable to straighten it.

This work was done last winter, the intention being to make the survey while the leaves were off the trees and the river frozen, but as no suitable opportunity offered, this work was deferred until the spring floods were over and the water had subsided.

Before beginning the field work a plan for staking out the drain was adopted, as follows: To set grade stakes in the center line each two chains; to set a stake at each angle; to set hub stakes by each grade stake, not in the river; to witness every angle stake, and to establish benches at suitable distances. A chain was used to measure the distances, because that put them on the same basis with the land lines, thus making the computations easier. No slope stakes were set, as the notes give the width of the drain at each grade stake, and the width can be easily determined from the center stake. A railroad compass was used in running the lines, it being more portable than a transit, and as the needle was relied upon to determine the direction of all lines, it was found to be sufficiently accurate.

The grade stakes were numbered with arabic figures cut on with a timber scribe. The angle stakes were numbered in the same manner with Roman numerals. Each bench mark, of which there were seventy-nine, was also numbered. Plans were also made for connecting the different courses with curves having a radius two chains long.

On the twenty-fourth day of last June, a party was organized, and active operations in the field commenced, at the outlet of the proposed drain. The angles were first located and substantial stakes set, then the grade stakes were set in line between these at the proper distances apart; where the water was not too deep the chainmen waded in the stream; when we came to a deep hole, a boat was used to aid in setting the stakes. This boat made a very convenient means of crossing the river, which was necessary at frequent intervals.

For measuring we used a No. 14 hard brass wire, two chains long, with a ring in one end by which it was dragged along, and a small loop in the other end through which the rear chainman slipped a stick that served as a handle when a measurement was to be made. This stick was then slipped out, and the wire dragged along. This made a very light and convenient measure, and remained of constant length, as we found by frequently testing it with a steel tape. A steel tape was used to measure the fractional distances between the grade stakes and the nearest angle stake, so that the length of the courses could be computed; the points where the drain left the river channel and re-entered it were also noted, to aid in computing the amount of cut.

The river channel was followed wherever it could be done without deviating too widely from the general direction of the drain, as it is cheaper to clean out and deepen the present channel than dig a new one. It often required a considerable knowledge of woodcraft to cut across the bends to the best advantage without making a traverse survey of the whole river, as this was deemed too expensive to be undertaken. The plan usually followed was to locate both ends of a proposed cut; then cut a line through by shouting back and forth, being directed by the sound. This might seem a little crude, but it proved to be effectual and expeditious.

I have drawn a sketch of one and a quarter sections of land, with the course of the river and the changes made. This will no doubt give you a better idea of the plan followed than I could describe in words.

Only those land lines which could be easily found were noted while surveying the line of the drain. Mr. F. E. Smith, the surveyor of Cass County, followed along later, and definitely

located the points where section lines were crossed, also quarter lines, where convenient. From this data the minor land line crossings were readily computed, with the aid of a traverse table.

Nothing was done at leveling until the survey line was completed. Then we began at the lower end of the drain, and proceeded with the leveling upstream. Levels were taken at the foot of each grade stake in the river, and on each hub. It was decided that the most convenient place for the benches would be on the trees used as witnesses to the angles. This was done by cutting a notch in the tree near the ground, and driving a nail to serve as a point from which to level. On long courses benches were established in a similar manner, and noted from the grade stakes. At each stake in the channel of the stream the depth of the water was read and noted, and this made an efficient check on the levels, as the current of the stream is uniform, there being no rapids.

While this account of the field work might indicate that it was uneventful and monotonous, such was not the case. The swamps were alive with mosquitoes, that made it exceedingly interesting while writing notes or taking an observation with the instruments. Then there were patches of rank nettles to tickle one's shins and hands, and scores of massasaugas lurking in the weeds, ready to strike on the slightest provocation; also blue racers and black snakes galore to threaten one at every turn. We often thought of that injunction, "My soul, be on thy guard, ten thousand foes arise."

The length of the drain, from where we began to the lower end of the State drain, is 1,002 chains and 75 links. The difference in height of the two ends, taken at the surface of the water, is 34.6 feet, the grade increasing somewhat from the lower toward the upper end. Two grades were established in the drain, the lower 440 chains having a rise of two feet to the mile; the balance, 2.8 feet to the mile. It would be preferable to have the steepest grade at the lower end of the drain, to prevent a deposit of silt from a slacking of the current; but the change of grade is so slight that I apprehend no serious trouble from this source.

The average depth of the drain in the cuts is about five feet; in the river channel it varies from nothing to three feet.

The total area of the swamp to be drained is about 15,000 acres. To drain this area the drain was made twenty feet wide on the bottom at the lower end. This width was maintained for the lower half, the balance being sixteen feet on the bottom.

On a drain of this character the general surface of the ground determines to a large extent the grade of the drain, as long, deep cuts would make the cost excessive, while the drain must be deep enough to drain at least nearly all the land adjacent to it.

The width, however, is a matter that requires a close study of the surrounding country, both as to slope and character of soil. The water from a slope will discharge into a drain more rapidly than from a level tract, hence would need a larger drain to prevent flooding. Again, the water would discharge more rapidly from a clay soil, or one having a hardpan near the surface, than from a gravelly or a mucky soil. Several formulas are in use to compute the size of drains for different areas, but to be successful we must study the character of each drainage district, and modify our rules as circumstances seem to indicate, always aiming to make the drain sufficiently large.

Notes.— In describing the route of the drain, the point where it enters each description of land, the length and direction of each course, the total length of the drain on each parcel of land, and the point where the drain leaves the land, were given.

The balance of the notes were made in the form of tables, one showing the witnesses to the several angles, giving the size and variety of the trees, with their distance and bearing from their respective angles. This table also gives the various benches, their height above datum, their number, and the direction of the bench from the center of the tree. The other table gives the dimensions of the drain at each grade stake, including depth, width at bottom, width at surface, and height of bottom above datum.

These notes were printed in full on each right of way, also on all the other papers requiring a description of the drain. This arrangement makes plain to each landowner the exact size of the drain on his land, thus obviating any occasion for misunderstanding. We follow this same plan in laying out all the public drains in the county, and find it both cheap and convenient.

The total length of this drain is a little over twelve and one-half miles; the distance between the ends on an air line is eleven miles. In other words, the drain is one and one-half miles longer than it would be were it straight.

The amount of new channel, as compared with the total length of the drain, is 44.5 per cent on something less than one half; there are no deep cuts to make, and there are very few indications of quicksand.

There appears to be a stratum of gravel about five feet below the surface over most of the course. This will make a splendid bottom for the drain when laid bare. The work of excavating this channel will necessarily be done with a dredge, as there is always too much water to admit of its being done by any other method.

This drain is one of several similar ones that we have under consideration in our section of the State, and while they will each cost considerable money, they will cost less per acre of land benefited than many smaller drains.

These large drains, when properly laid out and constructed, make an effectual outlet for the drainage areas under consideration, and make it possible to reclaim many acres of fertile land, besides relieving the congestion that is often caused by using the smaller rivers as a dumping ground for the drainage from higher lands.

A RECENT ARIZONA EXCURSION.

A. W. BARBER.

Nearly twenty years ago, some of the wild Navajo Indians in the northeast part of Arizona brought to their agency officials, from a remote region about one hundred and fifty miles away, numerous pieces of bright blue and green rock, as samples of large deposits. Finding it to be a strong ore of copper, the whites who were in the secret, formed expeditions, camped all about the ore beds, dug shafts, took out ore, and took up over forty mining claims. They guessed at courses, paced off distances, set up hasty corner stakes, and stone piles, wrote out claim notices, and sent or carried them to the then county seat, about two hundred miles away to the southwest, where said notices are now submerged in a flood of over fifty thousand similar claim filings.

In the midst of this activity, in May, 1884, by an order of the president, that section of the desert was made an addition or extension of the great Navajo Reservation, and white men could cross its boundary only at their peril. The executive order contained the usual clause reserving to any actual settler or miner all his prior rights; but some bloody affairs took place, and it was unsafe for any one to exercise these rights by returning to his claim to perform the "assessment work" required annually to hold title according to mining law.

The low price of copper, and the expense and hardship of all the conditions, caused general neglect of these deposits. But as the price rose, the interest of both poor miners and capitalists was revived; and attorneys, seeking recognition of these rights, obtained last April from the Interior Department, not only a decision that the prior claims are still valid, but also an order that all such miners' claims should be surveyed and segregated as public land of the United States to which the Indians have no title, and subject to formal entry under the mining laws, although each detached claim lay far within the land of the Navajo tribe.

Within a few hours after this decision, the writer was called

to headquarters, and told to depart at once for Arizona, and execute the required surveys, not under rules of the mineral division of the office, but simply to mark out and locate these bits of government land. Entering a Pullman at Washington, I saw again the map of our country unrolled for five days and nights, and left the same car at Flagstaff, Ariz., a pleasant town with an altitude of seven thousand feet, near the south base of the great volcanic peaks, Mt. Agassiz and Mt. Humphrey, the whole great isolated mass being named the San Francisco Peaks, and having the fine elevation of 12,800 feet above the sea.

To select, equip, and fit out a party of helpers required but a few days, though it is a very unwise thing to venture on a long trip of hardships in a lonely desert with an outfit of doubtful qualities. There must be no breaking down of the wagon with its load; we must have no horses but the truest and toughest, no weaklings or shirks among the men, and no lack of any of the hundred indispensable things needed for food, shelter, cooking, and work.

Life and death on this trip depended on the large cask of water, the heaviest item of the cargo, from which men and beasts were to slake thirst during the first two days, and many subsequent periods. The road of lava and clay that wound among the foothills and pine woods, does not afford a drop of water, nor has it a settler outside of the town. Descending at last from the lava hills and pine woods to the vast, lonely level of Deadman's Flat, we were overtaken by evening among its low, scrubby, and scattering piñons and red cedars, where we made our first dry camp, and spread our blankets on stony, sandy ground under the cold stars of a windy night. My excellent teamster was cook and general camp boss; but every man of the party of five was equally at home in all the queer and trying situations of the expedition.

North and east we fared, crossing a wide valley with low, rocky hills and ravines. Suddenly the scrub cedars came to an end, and only bare, undulating desert lay before us. Taking the ax, the men secured a lot of crooked dry wood, and piled it on the bed-rolls of our loaded wagon, so that we might not fail to have warm meals and camp fires at night and morning. Toward evening we wound down a steep, risky track on bare rock,

to camp in a wild gulch of red, jagged conglomerate, as near as one could drive to the precious Cedar Tank, a broad pool of good water in a cave under projecting cliffs, at the bottom of a deep-worn gully. This dark shaded bowl of rain water survives all drought, and has not a tree, or bush, or blade of grass to point out its hiding place to the thirsty wayfarer.

The horses knew the way to clamber by a long detour down to their drinking place, and next morning we carried water in pails to refill our cask. A mile farther on we crossed the Little Colorado River, at the head of a vast "box-cañon," which grows deeper and grander all the way to its junction with the Grand Cañon of the Colorado, some thirty miles northwest. The sandy bed was dry, except little pools near one bank. The water was yellow and undrinkable from alkali and other unsanitary seasonings. Winding up over plains and hills of worn flint pebbles, the road enters the region of the "potato hills." The men had expected to astonish me with the wonderful coloring, and the beautiful contours of this strange array of residual mounds and hills, where the rains of ages had sculptured away the clay deposits of a great cretaceous area. But I told them that though very beautiful, their forms, size, and color should be multiplied by five or ten, to equal the grandeur of the views of the Bad Lands of the White River in South Dakota, where exactly similar deposits are on a grander scale, and on whose crests I had so often set up the transit.

While eating our noon meal, a cold norther began to blow, and the men began to dread that the usual sand-storm would prevail, which they had so often endured in crossing the great desolate flats of Moen-copie Wash. The gray dust soon filled the air, and shut out the surrounding hills. The road was drifted deep with dry sand, the team labored and panted and rested, and the mica sand-goggles had to be put on to save our eyes. The coarser particles stung the skin like winter sleet. The ragged row of cottonwoods along the bank of the Wash bent to the gale. The deep, dry watercourse was hard to pass, and shovels were used, to work a passage through the drift of sand that at first stalled the team and wagon.

At last among hills again, we dragged along, walking for warmth, looking anxiously through the gloomy night for the

first ray of the lamp of a lonely trader, who has the first habitation visible on this road in the whole seventy-five miles thus far traversed; about nine o'clock we were able to halt, and make our camp beside a stable, cook a late supper in the cold wind, and sleep once more on sand and gravel. The load was growing lighter in consequence of our having fed the horses three times a day, their rations of oats and pressed alfalfa; but more feed was bought of the trader, who procures his stock from a small Mormon settlement, twelve miles off our road, where a little stream enables them to irrigate and farm about one hundred acres in all. The wood we had cut some twenty miles away, here served to cheer our camp.

This place is Willow Springs, where a clear little rill (margined, however, with white alkali crusts) comes out of a rocky gorge, and soon is lost in the thirsty red soil. Like Cedar Tank, it has at present not a willow nor a cedar in sight. On an upper bench a few Navajos live in their hogans (accent the gan strongly), or dome-shaped huts of poles and bark shingled with dirt; and they irrigate sloping little garden patches of corn and perhaps vegetables. From the road or the store not a hogan can be seen; yet all day long Indians come and go on their ponies, from the wildest retreats many miles away, to barter or buy for cash, but not to beg of the trader, reserving that compliment for us transient victims of sentiment.

An Indian rides up, unties and carries in a new blanket that has never been seen by a white man. The trader unrolls it, notes the quality, and mentions the price per pound. The manufacturer grunts his assent. It is laid in the scales, the price in silver counted out, and the blanket is then piled away with hundreds of others, waiting to be shipped in bales to Flagstaff, and thence by train to all Eastern markets, where these gaudy rugs of native American make are sold at fancy prices. Of course we improved the occasion to purchase samples. Of the thousands to be seen in the stores, no two blankets have the same design. Infinite originality works in the fingers of these swarthy weavers. The coarse wool from their flocks of black and white sheep, partly dyed with brilliant aniline from the traders, is all carded by hand, and spun into yarn without a wheel. All weaving is done without a loom. A square vertical frame of poles, set up outside the cabin, holds

the warp, and the filling is laid in with the fingers by short and long yarns of the chosen colors, so as to produce the most remarkable figures and results. For fine, thin blankets of greater elegance they use cotton warp and Germantown yarn, both bought of the trader; but the designs and the art employed are wholly of the same savage sort.

With his cash in hand, the Indian buys his supply of coffee, flour, sugar, pork, and other necessaries, ties them to his saddle, and disappears up among the red rocks on his homeward trail. Not a word of English is spoken in this trade. The merchant is master of their language, and so is his clerk, my Mormon friend, Joe Lee, whose uncle was the famous Mormon leader, John D. Lee of bloody memory, who died in the noose of justice twenty years after his crime.

The fourth day led us along a dry run of absolute desert, walled by red and brown cliffs upheaved to mountains on one side, till after twelve miles of slow ascent, the team wound us up to the top of a rocky gap, by a terribly steep and risky climb, with every man helping to keep the wagon from total wreck. Here we looked north over an unbounded desert, nearly treeless, where soon the hard-beaten track changed to deep, dry sand, and the party went on foot, that the weary team might last the journey through. Fatigue and approaching night made us camp some miles from the next water. To shelter us from the keen wind, I chose a cave on the lee side of a high rock that rose sheer from the plain. Small dry brush was found for cooking supper, and the night was apparently but a few minutes long.

Next morning the thirsty team reached Scarbreast's spring. Near the foot of a mountain ridge is a natural pit in the sandstone containing a filthy, green pool, at which every pony, sheep, and goat for miles around takes his daily drink. Near by a trench, or crosscut, has been run to the bluff, hewn in the red rock, fifty feet long and eight feet deep, to gather a trickling of pure water. Back in the gorge above lives the impudent old proprietor, with his families; and whenever they see a white man's team approaching far across the plain, down comes this filthy animal on his pony, to collect his dues. A quarter for watering a suffering team, and a dollar a barrel for spring water carried away, is the mildest charge on the books of this interesting aborigine. Our

party, sent to do government duty, was required to pay such tribute, or provoke an Indian war by refusing.

Gaffer Scarbreast is rather infirm with pulmonary symptoms; but he and his boys manage to loaf around the miners' and surveyors' camps till mealtime, when they must be fed; otherwise we lose favor in their eyes, and one or both horses might be found missing, to be discovered only by a handsome offer of reward. He has three squaws, but Indian etiquette does not permit them to swarm up to the camp fire, and insist on a share of the white man's small grub pile, as the universal custom of the male savage dictates.

His squaws are stationed in different places, a mile or so apart, each being in charge of some 200 sheep and goats, herding them where the scant, dry grass is best, for there are traces of grass down in the sand of the hillsides. They move from one hogan to another, with brush-fence corrals in which to fold their motley flocks against the coyotes. Goats and sheep seem in equal numbers, and the black and white and spotted flock is a droll sight. A black Navajo sheep, though exposed from birth to the bleaching power of the brighest sun, is not brown in the least, but as purely black as the blackest of cats. Others yield the whitest of wool, and these facts add to the beauty of the rugs.

Local tradition tells how a gang of these natives were some years ago interrupted in a grand horse-stealing raid, across the river; how the Mormons chased them, and shot every one; but that this precious old relic of barbarism, though a bullet had bored him through the lungs, yet reached the Colorado River down in the depths of its cañon, and swam its broad torrent alone to safe shelter on his native shore. Thus unluckily he yet lives, to lord it over his squaws and their progeny, and over us white men who are compelled to journey through his realm. All of the barrels of the precious fluid used in my camp, and all the supply of a dozen copper miners, were hauled ten miles in deep sand, after being dipped up from the feeble flow in the bottom of the trench. When I sent two men and a team to dip and strain and bring a barrelful, it occupied all day, and cost a silver dollar; but the miners had to employ the pony team of the Scarbreast tribe to haul their supply, and paid two and a half times as high a price.

These natives accept no money but silver. The oldest son is

a savage dandy with his finery made heavy with superfluous silver buttons, plates, and rings of barbaric design. There are many alleged silversmiths among them, who work up surplus coin into coarse ornaments for man and beast, and even make silver spoons so rough, angular, and useless that tourists buy them as rare souvenirs. All my memories of those natives are tiresome and exasperating, except only this, that they sold us first-rate mutton carcasses, which were most welcome at our rustic table under the cedar tree.

At last, on the fifth evening we pitched our tent beside the copper diggings, fully one hundred and twenty-five miles from Flagstaff, and only some twenty from the Utah line. Although weary from long tramping, I ascended a sandhill, set the transit, and observed Polaris at elongation near midnight, for true meridian. The next day was passed in training the new chainmen to exact work, running a meridian line over hill and vale some three miles north. The spaces between marked stations were chained both ways, to test their accuracy, and one portion four times. The day could not have been better employed.

The mining claims were described in the old filings in the usual form; for instance, "beginning at discovery shaft and rock-pile, running thence 500 feet northwest and 1,000 feet southeast, and extending 300 feet each side of the center line of the lode; said Gopher claim lying two miles northeast of the Copperopolis claim and one mile east of the Twelve Apostles." Everything was largely vague as to distance or direction, and sometimes even as to the identity of the ancient pits and recent workings; but some of the original claimants were with me, and in several cases their sworn testimony was taken, and filed with the field notes. The claims were widely scattered over rocky buttes and sandy valleys, for five miles east and west, making several camping places necessary; and the lines ran up and down the face of many a steep ridge 200 or 300 feet high through a tumbled mass of angular fragments, or over vertical cliffs requiring triangulation.

These strips of land 600 x 1,500 feet, or nearly twenty acres, were surveyed and recorded in chains and links as all public land work should be, and were marked by a monument at each corner, marked PL on the side facing the interior, and NR on the opposite side for Navajo Reservation. A stone monument was used

in every case, with a marked stone memorial buried beneath, and a large stone mound alongside, or bearing trees suitably marked. But it often happened that the corner point fell on a bare ledge. Then I either cut a cross on the rock with the above letters, and made a witness mound, or else set up a long fragment of rock, supported by half a ton of other stones, with the requisite witness trees or stone pile.

Not a single wooden stake or post was used for a corner in the whole thirty-five claims that were identified. Permanency of establishment is the final and indispensable requisite of a good survey. It is several years since I have yielded to the common practice of the careless and indolent, of setting a wooden stick, which any Indian or camper or herder would be only too glad to pull out and use in his camp fire,— a practice I have witnessed in Nevada. If this rule of permanent stone corners were adopted by the average county surveyor, it would cut deeply into the profits of the profession. Nothing is a more prolific source of future calls for work, than to mark a careful survey with a trifling stake or clod, trusting to the farmer's promise to promptly put in a good reliable corner, which he generally forgets to do.

At the north end of my meridian, a line was run east and west about five miles and marked by monuments at measured distances. To these definite points on two lines, every claim was connected by exact solar course and chained distance, uniting them in one connected whole. The Department had also ordered that the survey be definitely located and its position in the desert fixed, by actual survey of a line to the nearest established section corner of prior surveys. So when ready to return to the land of white men, I began a line at my meridian station, took the course to a tree on a bluff three and one-half miles away, and started the chainmen and team on the home stretch. Long or short courses were used, as the ground allowed, two of them being six and eight miles at a single sight; and landmarks were chosen, that would keep our line near the wagon road, if possible. This was not a meander line, for meandering only applies to the shores of waters.

On the sixth day of this toilsome progress, I "set up" over a section corner of a recent survey, not yet reported for examination, but the character of which it was desirable to the Department to ascertain. I therefore retraced it for some three

miles. It was part of a guide meridian forty-eight miles long, and should have a due north course, exact distances, and good monuments; but none of these were found. Portions of the line deviated as much as a whole degree east of the meridian course. It was merely one of the common attempts to do cheap bungling work with a needle compass, without regard to any sort of solar or stellar observation for the meridian. The number of the contractors who still persist in going by the needle and take a "variation" as their guide, contrary to law and to their oath of office, would surprise all who are now worthy the name of competent surveyors,— that is, who discard the tricky old needle and survey by something reliable.

Later in the day we left the sandstone desert and began crossing the beds of black lava vomited by the volcanic peaks we were nearing. Knowing how very magnetic these beds are, I let down the needle after using the solar, and found the variation had changed from 14½° to 19°. Thence running across a vale to a lava point about a mile away, I again took the solar meridian, tried the needle, and found the magnetic declination only about 12°. This shows what chances an incompetent surveyor can have, armed with an old needle compass or transit, in any attempt to execute work that would stand inspection by the methods now used by our examiners.

On the seventh day at noon I closed my angular connecting line to an old section corner, finding the total distance over eighty miles, the last eight miles being in a rain and thunderstorm, which at one time made the chainmen drop the 400-link tape for fear of lightning, and take to the rocks for shelter. Two more days of travel among the pine woods and foothills were still to be made. The last camp was at a beautiful farm by a running spring 8,300 feet above tide level, where snow still lay in the woods, and the peaks towered far above timber line close at hand. Then down, down the well-graded road, out into the open valleys, and to the shining town of Flagstaff. After thirty-three days of toil and travel, on May 15, we returned, eager to find water enough for a bath, to sit once more in chairs, to experience the sensation of good table-fare with silver, china, fruit, and ice-cream, to renew acquaintance with a good bed, to read up the lost news of the busy world, and to enjoy letters from home.

TIMBER CRUISING.

D. A. BROTHERTON.

The timber cruiser is a person who explores lands for the purpose of estimating the amount of merchantable timber they will yield.

To make a success of his work, he must be a good woodsman, be able to follow lines and trails, and distinguish one from the other. He must know how to run lines and how to make trails; and the more he knows about the manner in which the original government surveys were made, the easier and better will be his own work.

He must know how to subdivide sections properly; hence he should have a knowledge of surveying. He must be able to recognize the different kinds of timber and know the use and value of each, and how each is procured and prepared for consumption. He should know which soils are good for farming, and which are not, and a knowledge of geology sufficient to enable him to recognize mineral-bearing rocks and soils is very helpful.

In examining timber lands in upper Michigan and northern Wisconsin, where most of my work has been, I make an estimate of the pine, hemlock, maple, birch, basswood, elm, beech, ash, cedar, tamarack, spruce, balsam, and poplar. There are a few others met with occasionally, such as butternut, oak, and cherry, but they are seldom found in quantities sufficient to estimate.

I carry two books, one in which to sketch the lands, making note of streams, lakes, swamps, hills, roads, and so forth, and in the other I keep the estimate of the timber. In recording the estimate I use the diameter of the trees. I can then compute the amounts for the different kinds from tables giving the average amount of lumber in logs for different sizes of trees and for the different timbers. Should the trees be exceptionally tall and straight, or very short and rough, I make note of the fact and add to or deduct from my estimate accordingly.

In doing this work, I count every pine tree, all the basswood and elm on one fifth, and the other timbers on one tenth of the lands. To do this and get a fair average, I divide the running

into tallies of one hundred and twenty-five paces each, making four tallies across each forty-acre tract. I have a man to run the lines with a pocket compass and do the pacing while I give my attention to the timber.

Pine trees I count one tally to each side as we go along, basswood and elm four rods on each side, and the rest four rods on one side, alternating with each tally. By running twice through each forty, one tally from its sides gives one eight tallies or a count of eight acres of land for basswood and elm and of four acres for the other timbers, excepting pine, of which every tree is counted.

Where swamps and ridges or bunches of timber are in such a position that my count does not give a fair average, note is made of the fact and calculations made accordingly in figuring up the estimate.

I estimate pine trees by measuring the smallest diameter of the trunk where it would be cut off and taking note of their shape and condition. Unless a tract of land is very thickly and evenly covered with pine that varies but little in size, I estimate each tree separately; but one will occasionally find a forty timbered so heavily and evenly that a count made as we do for the other timbers will give a good estimate.

The estimates of the different species of pine are kept separate.

The white pine is the most valuable. Its wood is very light both in color and weight. Of the white pines there are several varieties, the best of which is the large "cork pine" easily recognized by its thick rough bark and the stately manner in which it grows. It is the grandest of our forest friends. Then there are the "thin bark," a thrifty tree with thin, smooth bark, the "buckwheat" which branches out not far from the ground making two to eight trees from each stump, and the "ladder pine," so called from the fact that its branches start close to the ground, making it an easy tree to climb.

Yellow pine, commonly called "Norway" in most localities of our pine country, is not as valuable as the white. It is very much used for piles in dock and bridge building. The wood is heavier and darker than the white pine, and very resinous. The bark is yellowish, and not very thick.

The estimate of hemlock is divided into the number of feet,

board measure, number of ties, and number of cords of bark. In computing the amount of lumber to be gotten from hemlock trees I use a different table from that for pine. Hemlock is much shorter than pine, and generally four to eight feet must be cut from the butt of each tree on account of shake. Consequently my tables give this a much less estimate than the pine; in fact, it averages less lumber for the same size tree than any of the other timbers. Trees that cut over ten logs per thousand feet, board measure, I usually estimate for railroad ties. Bark is calculated as being taken from all hemlock from about fourteen inches in diameter up.

Basswood and elm are estimated alike for lumber. They yield more than the hemlock but less than the pine; therefore I have a separate table for them.

Black and yellow birch are estimated from a table giving averages greater than the hemlock, but less than the basswood and elm table.

White birch is estimated by the number of cords.

Maple is estimated for lumber, using a table giving averages between the birch and the basswood tables.

Ash I calculate from the birch table, and beech from that used for maple.

Cedar is estimated in ties, posts, and bolts. Where good poles can be cut, mention of the fact is made, although unless specially requested, I include such trees in the tie estimate. Sound, straight, and fair-sized trees are put down for ties; small ones for posts, and overgrown, dead, or imperfect ones go for bolts, or when desired, are calculated in feet, board measure.

Spruce, balsam, and poplar are estimated in cords. The trees are counted in the same manner as the other timber, and the estimate calculated from tables giving the average number of trees of each size that will be required to make one cord.

Tamarack is estimated in ties. It is used principally for railroad ties and for timbering in the mines. As the mines buy it by the running foot, an estimate in ties gives a fair basis for valuation.

The timber cruiser takes many long tramps and endures many unavoidable hardships; but he also has many pleasant journeys, and enjoys many an evening around the camp fire. All seasons

have their advantages and their disadvantages. With the springtime comes wet swamps and high streams, but I have yet to meet the man who does not enjoy the spring air filled with the scent of new buds and flowers and with the songs of birds returning from the South. Everything, even the trees and bushes, seems to enjoy the spring.

Summer brings mosquitoes, flies, spiders, and bugs innumerable to pest the woodsman. This is the season when he "earns his bread by the sweat of his brow." When it is warm in town or on the farm, it is hot in the woods, and when they get it hot, we get it hotter in the timber, where we receive but little benefit from the breezes. But we generally find some fishing or hunting for our spare moments, and often we enjoy our fill of berries in their season.

When fall commences, we look for wet weather, and generally find it. Then we get long spells of wet, disagreeable weather, and often are caught in showers, and come to camp soaked and cold. Swamps and creeks fill up, and lucky is he who gets to camp at night dry. But when we are favored with nice weather at this time of the year it is thoroughly enjoyed. There are no flies or mosquitoes, and one can appreciate life in the woods. Camp fires begin to feel good, and as the evenings lengthen, we gather around the fire, and spend the time swapping yarns and relating experiences of bygone days.

As the weather grows colder and the days shorter, we realize that winter is coming, and a stove is added to our outfit. Then, though we may get tangled up with our snow shoes, and get covered, yes and filled, with snow during the day, we have a good warm camp to go to when our day's work is done. This remark is often made to me: "I should think you would be very cold camping out in winter." I probably would if I did in winter as in summer, but any one who visits our winter camps will be satisfied that life in tents can be made very comfortable, even in cold weather. Winter brings hard work though. The days are short, but when it is cold, one can work harder than in hot weather. I find that on the average we do as much work during the short days of winter as in the long summer days.

But winter, spring, summer, or fall, whatever the season, the woods attract me always. I find thorough enjoyment travel-

ing around day after day watching, counting, and studying my timber friends. Though my route be different each day, no matter what way I go, there will I meet with familiar faces, each with a story of its own, each with a sigh peculiar to its kind, as the light wind strikes it, or a roar, as the blast of a gale tears through its branches.

The lover of nature can always find something new and interesting among the trees. Let us take a look at some large, hardy, sugar maple, which to the superficial observer is simply a very fine specimen of the hardwood tree. Let us go up to it, and make its acquaintance and see what its past life has been. As we near it, we notice that it does not stand exactly perpendicular, but leans over somewhat. If it could tell its story, we would learn that years ago a terrible wind swept the forest, and though this tree was strong and sturdy and withstood the trial, the wind left its mark. Scars along the trunk tell of other trees in falling striking and injuring the tree, but nature provides each of its children with methods of healing, and now the wound is scarcely discernible. Again, what means that "V" shaped scar a couple feet from the ground? It tells us that years ago an Indian, or maybe some early pioneer, cut into the tree to catch sap from which to make syrup or sugar. Thus a close examination of most trees will reveal to the investigator stories of the tree's life, and of accidents that have befallen it.

Nor are the trees alone in holding secrets of bygone years. The surface of the ground presents to us indisputable proofs of battles waged between the timber and the wind. Very seldom will we find a perfectly smooth surface in a timber country. Nearly every little knoll marks the place where some tree lived and died. I have seen large tracts of heavily timbered lands where the surface of the ground was full of knolls and holes, showing that there were once other large trees covering the ground, but some heavy wind had blown them down years, perhaps centuries, ago.

One feature of timber life that has often drawn my attention is, that when one growth is destroyed, and nature has full swing in bringing up another forest, this second is invariably a different kind. For instance, a heavy wind blows down a tract of timber such as maple, birch, basswood, and elm. Generally the next

year the ground will be covered with raspberry bushes, which continue until another growth of perhaps poplar or balsam will drive them out. Poplar and balsam grow quickly, and soon they form quite a forest. As years go by, they in their turn are superseded by a second growth of small maples, birch, and so forth.

There are few places in Michigan or Wisconsin where this reforesting will not go on if the timber be left alone. Nature will do her part. Our part should be to do all we can to prevent anything impeding her progress. The principal obstacle to overcome is the danger from fire. Hunters, lumbermen, farmers, and woodsmen of all kinds are too careless in managing fires near timbered lands.

It seems to me that either the State or federal government should enact and enforce laws to stop the indifferent (one might say criminal) manner in which most people handle fire in our forest districts.

DRAINAGE, VENTILATION, AND HEATING.

A. B. RAYMOND.

When I received the invitation from your president to address you on the subject of modern plumbing and sanitary work, being unaccustomed to public speaking, my first impulse was to decline. The topic, however, is an important one, as is shown by the increasing interest taken in these matters by our municipalities. As it is the work in which I am engaged, I thought better of my first impulse, and decided to accept.

Our State law and city ordinances recognize the need of requiring proper sanitation of our buildings if we are to protect public health, and while not explicit in regard to private dwellings except as to drainage, they are very definite in regard to drainage and ventilation in the general sanitary conditions required of our public buildings, schools, theaters, and all places where labor is employed.

The State grants to our Boards of Health special police powers regarding matters affecting public health, leaving them to determine the needs of each case. Under these provisions we are able to bring about improvements in a great many cases which we could not reach under our city ordinances.

An act passed by our last Legislature, placing the supervision and regulation of all drainage and plumbing work, in cities of 15,000 and over, under municipal control, makes our subject of special interest at this time.

The sanitary influence of good drainage upon the healthfulness of a community is too well known to need much mention here. At the same time the public at large is not so well informed, or the poor work being done would not be tolerated with such indifference.

The lack of power to control and improve existing conditions in drainage work, has made necessary the enactment of law to protect the public against unsanitary conditions which result from poor work.

Claim is made by some that sewer gas (that is, the air from our drains) is not so bad as at first supposed, and that the dangers

from it have been greatly exaggerated. My observation has been that those who are conversant with such matters testify to the contrary. In belittling the dangers from it, they forget that sewer gas always comes in bad company, and its twin companion is organic matter, which is the enemy we have to fear. They point to the healthfulness of the men engaged in the laying of sewers, in support of their argument; but the fact is, those engaged in the laying of new sewers, work in the open air, seldom come directly in contact with the gas. The statement is made on good authority that the men engaged in repairing and relaying old sewers are not healthy, and do not continue many years at such work. The strongest men lose their strength in a few moments when suddenly brought in contact with the gas from some of our old sewers.

Any one examining our health reports cannot fail to notice the increase in sickness as cold weather approaches, and people are compelled to exclude the free access of the outside air from their buildings. We know that confinement in close and unventilated rooms will soon reduce our vigor, if not break down our health, and that outdoor life is more healthful than indoor life, showing clearly that the purity of the air we breathe is a factor which cannot be left out of consideration in matters pertaining to the requirements for the enjoyment of good health.

The questions then naturally arise: What are the causes lowering the purity of the air in our rooms? How can we prevent such condition and maintain it at the same standard as the outside atmosphere? Investigation on these questions shows that respiration is one cause, and the escape of air from defective drains, another. To remedy the first, we must have sufficient change of air to overcome the effects of respiration, and, for the second, we must find out where and why air escapes from drains, and then have the work so constructed as to prevent the same.

In all communities the first settlers resort to the outdoor closets for the care of waste material, but, as places grow and population centers, the offense from these closets and the appearance of typhoid fever due to contamination of the wells from them, cause, sooner or later, a call for a different disposition of the house wastes. In many cases, where suitable soil is available, this is accomplished by land application through a series of under

drains, returning to the soil that which enriches it for vegetation. Nature can dispose of such wastes more effectually and properly than man.

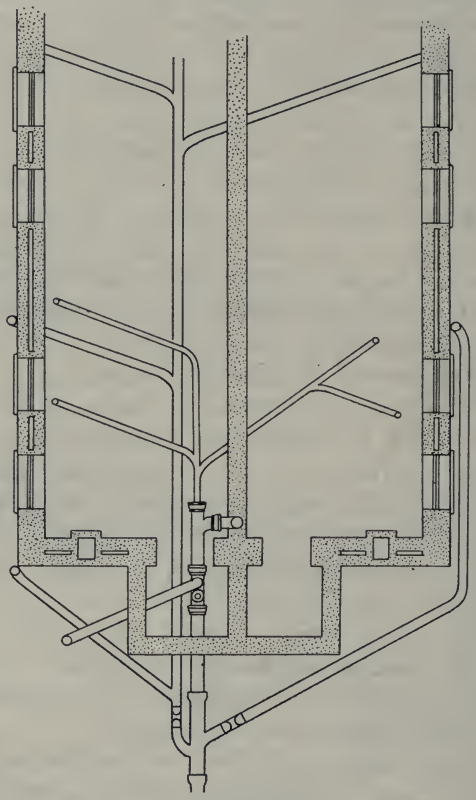
As a rule, however, when the demand comes for house drainage, the first step toward the solution of this problem requires the construction of a system of public sewers to receive the house sewage, and convey such drainage as a whole to some point for ultimate disposal. Unfortunately the practice has been, and is still, to convey the sewage of our towns and cities to the nearest bodies of water, thus polluting our public water supplies. But States, like communities, as they become more densely settled, legislate to prevent such pollution. Having a system of public sewers, we come properly to the drainage of buildings. Without taking time to go into the unsanitary work of the past, it will be more profitable to point out where the danger lies in the work of to-day, and the form of construction now employed to prevent such danger in the future.

The first portion of the work constructed is the drain from the main or lateral sewer to the house, known as the house drain. This portion must be designed of sufficient capacity to carry away, without overtaxing it, all the rain water which may fall upon the roof of the building and area ways during heavy storms, otherwise a flooding of the cellar will follow. This drain is generally of six-inch vitrified crock. No traps or hindrances of any kind should be placed upon this portion of the work to impede the flow of the house sewage to main sewer. The work is generally done by masons, and brought to within a few feet of the house, where it is left for the plumber. Into this the plumbing system, tile, and rain-water drains empty.

At this point, either just before or after the drain enters the building, a suitable trap, known as the house trap, is placed to prevent the entrance of any air from the main sewer into the plumbing. This having been done, the tile and rain-water drains are now laid.

It is a common practice to connect these drains on the inside, or house side, of this trap. When this is done, and a stoppage takes place, which frequently occurs, the house trap is where the obstruction will be found, as a result of which, the house sewage then backs into the rain-water and subsoil drain, the liquid portion

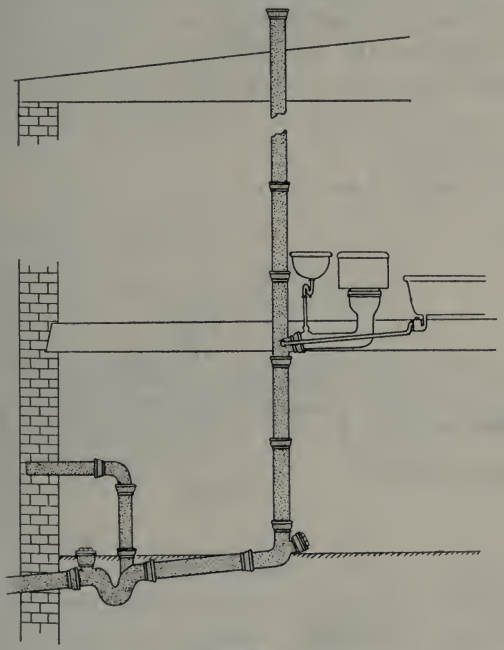
escaping through the open tile drains into the earth, while the soil gradually accumulates until an entire stoppage has taken place. This may go on for months before being discovered, causing much sickness among the occupants of the building. We have found so many such incidents in our city that we now



GROUND PLAN.

require the separation of the rain-water and soil drain by having them connect outside, or on the sewer side, of house trap, and that the soil drain under cellar bottom shall be of extra heavy cast iron, calked, and tested by the water test. Should a stoppage now occur, the tile and rain-water drains are safe from fouling, and the stoppage will soon be known by the overflowing of the lowest fixture; the clean-out to house trap can then be opened, the obstruction removed, and no fouling of the earth under cellar

bottom can occur. The house trap is now generally placed just inside of the cellar wall, and is an iron trap with accessible clean-out and a four-inch connection from house side of trap carried to the outer air, known as the fresh-air inlet or foot vent. The iron drain is then continued to the point where it is to go up through the partition to receive the soil waste of the fixtures, and is gen-

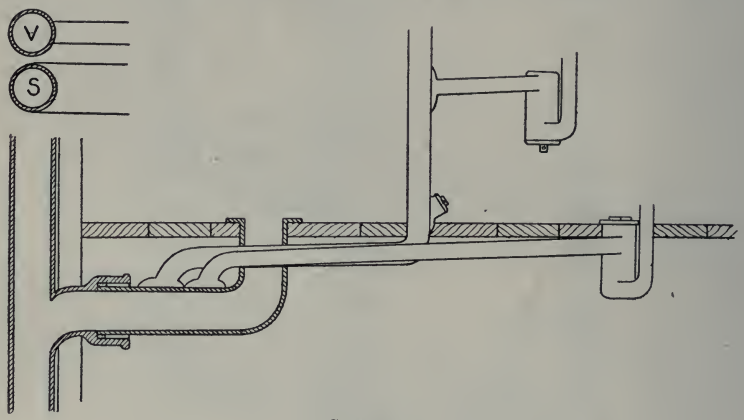


ELEVATION.

erally of four-inch wrought-iron pipe. This vertical stack is carried up full size, two feet or more above the roof of building, terminating with open end for ventilation. When this stack is carried up in a central and warm partition, the air is drawn into the soil drain at the fresh-air inlet, and flows through the system, passing out above the roof through the vertical stack, thus keeping fresh air within the lines. Into this vertical stack all the fixtures receiving the soil waste of the building above the basement floor, drain.

When there are several floors emptying into this stack, and especially in our high modern buildings where from three to twenty modern closets are in constant use, the fall of this body

of water unseals the traps of the fixtures below, leaving open communication with the soil drains, to overcome which a relief pipe, called the vent pipe, is run up parallel with the soil pipe; and into this two-inch connections are made from the top of the four-inch lead bend for closets. This communication to the air pipe prevents any disturbance of the water seal of the traps. Up to the present time, most cities require venting of all traps, which has largely increased the cost of plumbing work, and in many cases, as these vents were taken from the crown of the trap, grease and soap suds soon filled the opening, rendering them use-



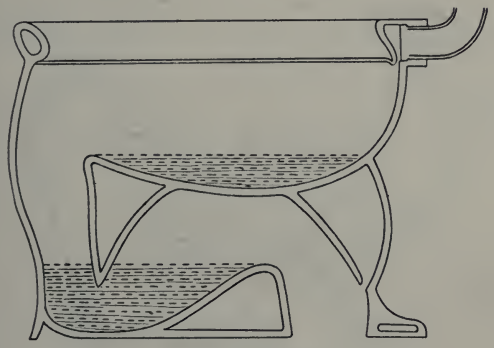
SECTION.

less and dangerous on account of supposed protection which did not exist. To-day, by better knowledge of construction venting is largely done away with, by the venting of the four-inch lead bends as mentioned, and taking the connections for the stands, tubs, and urinals from the tops of bend instead of from the heel or side as is generally done. Non-syphon traps are also used, and I can say that the Ideal Centrifugal Trap, one of the latest devices, has been put to the most severe test known for syphonage, and has never been unsealed. These traps are extensively used in our city.

It may be interesting to know how much control is had over drainage work and the manner in which it is tested.

Our Boards of Public Works, through the force of the City Engineer's office, design and control the construction of all public sewers; but when the work is upon private property, it passes under the control of our Health Departments. The moment the

drain enters upon private property, it is watched by competent inspectors until its final completion in the building. No work is now allowed to be covered until inspection has been made and the work accepted as having complied with the regulations governing the construction of our drains and plumbing. All the lead, iron, and steel pipes within the building before being covered are filled with water until it stands in the top of the vertical soil stack and the work is found to be tight; if leaks are indicated, they are found and corrected. Should they be due to defective material, it is removed, and a new test is made until the entire work is tight.



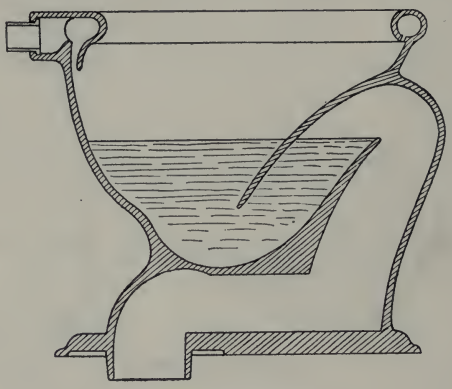
WASHOUT CLOSET.

When the building is over four stories high, the water test cannot be used with safety, and instead the air test under pressure of 8 lbs. to the square inch is employed in its place. This test is used on all high buildings and also during freezing weather in winter, as at such a time a thin coating of ice forms on the inside of the pipe as soon as the water enters, effectually covering defects which the inspector is trying to find if they exist. When the work is completed and all the fixtures are in place ready for use, a smoke test is applied as follows: —

Either at the fresh-air inlet or into the top of the soil stack above the roof, smoke is pumped until the lines are full, when the openings outside are closed and a pressure of ½ oz. is applied to the smoke within the plumbing work. This pressure is not sufficient to pass through the seal of a good trap, but it will reveal any defective work in the setting and coupling of the fixtures. When the work has stood these tests to the satisfaction of the

inspector, the health department issues to the plumber a certificate stating that it has been done according to the health regulations.

A word in regard to some of our modern closets as to their construction and value from a sanitary point of view. The one in most common use is the washout. In this closet the water receiving the soil is very shallow and does not allow it to be entirely submerged, and its action in discharge does not remove the solid waste from the water seal below, where it remains unseen but present, and from this cause these become very offensive at times unless they have care. The next higher in type is the

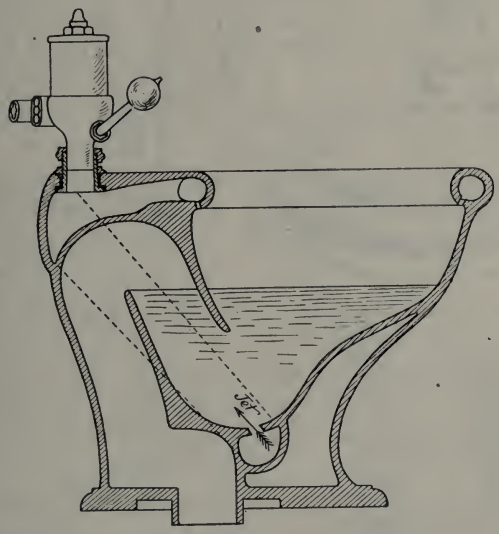


WASHDOWN SYPHON.

washdown syphon, which has a large body of water to receive and cover the waste, and its defect is, that unless there is a good flush and head of water the syphon does not form and is not easily emptied. The highest type of closet is the syphon jet; when this closet discharges, it is quick in action, and completely removes the entire contents of the bowl, refilling it with clean water. The new low-down syphon closet is now superseding the old high-tank closet on account of its being comparatively noiseless in its operation.

Another new syhpon jet closet is the volmeter, having no tank and acting directly from water pressure by valve action. We have used them in our new schools for over two years with perfect satisfaction. The school type acts automatically, as so many of our school children do not know how to use a modern closet, and will leave them undischarged. With two illustrations of condi-

tions which we are constantly finding, showing why we require a separation of the subsoil drains from the soil system, and use iron pipe under cellar bottom, I will leave the subject of drainage. One morning I was telephoned by one of our physicians that a certain family whom he was attending were having an unusual amount of sickness which did not yield to remedies effective elsewhere, and he felt sure there was some condition unknown to him to account for the fact, and he asked for an examination and



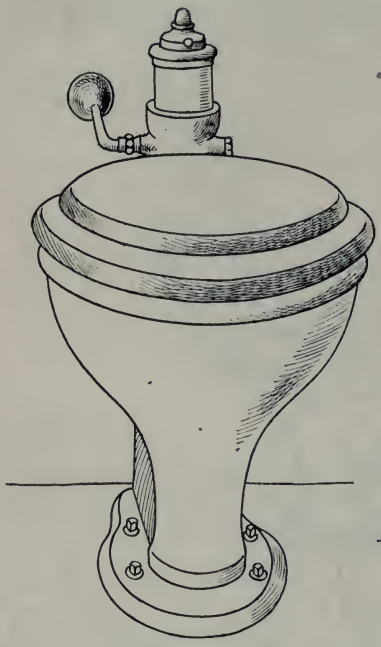
SYPHON JET.

report of the drains. The house was a modern one, heated by a warm-air furnace, and the plumbing, so far as could be seen, was in good condition. In such cases we apply the smoke test, and in this case we found the main house sewer was a crock one, with loose joints, passing under the cold-air box in basement, and as the furnace drew in the air from the outside, it was also sucking up air from the sewer, for smoke issued from the warm-air registers as soon as it was put in the drain.

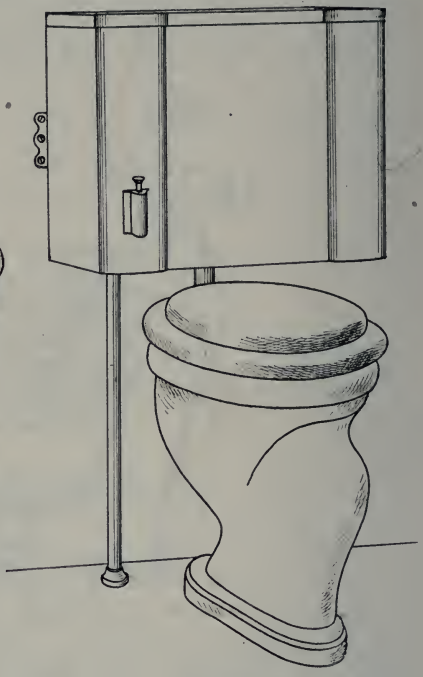
Another gentleman who was having more sickness than usual asked to have his drains examined. We found them completely stopped with the house sewage passing off in the earth under the cellar bottom. The little rootlets from the ivy which covered the house had taken possession of the tile drains, and the roots from

the large shade trees in the yard had found entrance into the main house sewer, a 10-inch crock, and for some 6 feet had not only filled the drain, but also burst it open.

The ventilation and heating of our buildings is a part of the work necessary for their proper sanitation. This work is a



LOWDOWN SYPHON.



VOLMETER.

science in itself, and I shall only touch upon it briefly to indicate some of the methods employed and their relative value in obtaining the desired end.

To properly ventilate and heat a building, we must heat and maintain at a uniform temperature the required volume of fresh air necessary to maintain the purity of the inside air, and also remove the vitiated air from the building. This requires a knowledge of the amount of fresh air to be delivered in a given time. The amount of heated surface in boiler or furnace to bring it to the required temperature, depending upon fire surface and proper combustion.

The fresh-air ducts and vent pipes must also be properly proportioned and located in order to deliver and remove the required volume of air in the given time. The velocities should also be so regulated that the change taking place shall not be apparent. In practice these velocities vary from three to five feet per second.

To maintain the purity of the air within a room at the same standard as that of the outside atmosphere, investigation has shown that we must bring in a fresh supply and remove the fouled air at a rate of not less than thirty cubic feet per minute for each person in the room.

The number of persons occupying the room therefore determines the amount of air required, and the size of the room, the number of changes necessary. These quantities, with the velocity, fix the dimensions of the air ducts and vents. The volume of air to be delivered determines, to a very large degree, the system of heating to be employed.

For ventilation there are two methods in use, the natural, or gravity, and the mechanical, or fan system. The natural method is generally employed in the ventilation of dwellings, office buildings, hotels, and in many hospitals, but for schools and public audience rooms it fails to furnish a sufficient amount of fresh air per person. It is also variable and never uniform, as the degree of ventilation depends upon the velocity which is governed by the difference in temperature between the inside and outside air, as well as by the atmospheric pressure from day to day.

In dwellings heated by stoves and open grates natural ventilation takes place to some extent, without any effort on our part, and in most cases is sufficient to prevent ill effects being noticed unless we are continually confined indoors.

The difference in density between the inside and outside air during cold weather causes the warmer air within to escape and at the same time forces in a supply of fresh air to take its place. It is this movement which produces the cold draughts noticed from our windows and doors.

In making investigation to determine the degree of ventilation found in different buildings, one circumstance has been observed which will enable any one to know whether a room is well ventilated or not, and that is the degree of temperature required

to keep the occupants from feeling chilly. In a well-ventilated room no discomfort or sense of chilliness is felt by a healthy person in a temperature of 68°, but when the temperature has to be raised above 72° to keep off this chill, the room is poorly ventilated. This unnatural feeling of chilliness in a warm room is caused by the undue amount of moisture thrown off by the lungs which is not being properly removed. The normal temperature of the body is 98°, and when there is an abnormal amount of moisture present at a lower temperature, it rapidly extracts the heat from the body, and the chilly feeling is a warning from nature that conditions are not what they should be. In a dry atmosphere we feel little discomfort in very low or high temperatures, but high humidity causes discomfort in either summer or winter.

Owing to the lower cost of installation and economy of operation, the natural method is used wherever it is possible, by it, to obtain the required degree of ventilation. But this system has its limits, and, when reached, mechanical methods must be employed.

In each system there are various modes of construction which are largely determined by the needs of each case. In both systems, however, there are fundamental principles which must be observed if they are to work successfully. I shall only attempt to point out the common forms of usage at the present time.

In houses heated by a warm-air furnace, the supply of fresh air is brought in from outside through an air duct called the cold air supply, which allows the fresh air to pass over the heated chamber of the furnace as it flows to the rooms above through the air pipe terminating in the floors, and which, if placed to get the largest returns, should be on the opposite side of the room from the windows or glass exposure.

Where a steam or hot-water system is employed to heat the building, the supply of fresh air is brought in through short ducts terminating under the radiators so as to heat the air as it enters, and all such radiators are placed on the outside of the room and under the windows, not only to heat the incoming air, but also to temper the cold air falling from them.

This falling cold air is often sufficient to effectually prevent the entrance of any warm air from a hot-air register. Two of

the principal causes of failure, among several, to properly heat a building by a hot-air furnace are the improper location of registers, and the lack of provision to remove the foul air, or to set up a circulation in the room. Air is like any other body, and has properties which respond to natural laws in regard to movement. There must be a displacement of air if there is to be movement.

For every cubic foot of fresh air brought in there must be, at the same time, a corresponding amount removed, as air cannot enter a room faster than it leaves it, and unless provision is made for such removal, heating is done at a great disadvantage.

It is not unusual to find two houses constructed nearly alike, one of which is heated comfortably on from ten to twelve tons of coal per winter, while the other consumes from twenty to twenty-five tons, and still its occupants are unable to keep warm. In the first case the heating plant has been properly installed, the rooms are ventilated, and there is economy of operation. In the other, the furnace is crowded to its capacity, and, from lack of circulation, little heat enters the rooms, but instead is wasted through the chimney; there is little ventilation, unnecessary cost, and a consequent waste.

For removing the foul air from a room by the gravity or natural method, vent flues must be properly proportioned and located to assist the working of natural laws in carrying off vitiated air. Air will not pass off unassisted through a cold pipe, therefore these vents must be located in warm inside partitions, or some provision made to heat them; if possible they are located beside the hot-air flue from furnace or boiler, and are connected in the attic to a central vent which passes through the roof, capped with a ventilator to prevent down drafts. Upon these vents it is good practice to place two registers, one at floor level, the other near the ceiling. The upper one is closed in winter and open in summer, the lower, vice versa. This construction provides for summer and winter ventilation, giving cooler rooms in hot weather and warmer rooms in cold with the least loss of heat.

Where for any reason a heat flue is not available, the lower register is raised to a point about 5 feet above floor level, at which location in a warm room, the air is hot enough to set up and maintain an outward flow so long as the room is heated. This form of construction gives very satisfactory results. The health

building in Detroit is ventilated as above described and heated by steam. In my own office, through a vent 8½ x 13½ inches, there is passing 6400 cu. ft. of fresh air per hour, or ventilation for three persons. I am not uncomfortable in this room in a temperature of from 60° to 65°; 68 seems warm.

In the mechanical system, among the various methods of construction, those which give the best results at a minimum cost are built along the following lines: —

The fresh air is drawn in by fans, over a series of coils heated by steam and arranged in sections so that one or all of them can be heated to bring the incoming air to the required temperature, as the degree of outside cold necessitates. Provision is also made to mix fresh cool air with the incoming heated air during mild weather, as the amount of air to be heated is constant, but the temperature varies from day to day. After leaving the coils, the air is forced by the fans through the various air flues or pipes to the rooms of the building, and is usually delivered from the inside walls opposite the windows at about 8 feet above floor level. A steam coil is also run under the windows to temper the cold air coming from them. In our newer Detroit schools a uniform temperature of 70° is maintained by thermostat connections. Some our of older buildings are still heated by warm-air furnaces.

On account of the variableness of the amount of ventilation from the warm-air furnace system (the amount seldom being above standard under the most favorable conditions, and during heavy weather only one third of what is needed), the furnaces are gradually being removed and the mechanical system installed.

In the successful installation of a mechanical system, so many problems have to be considered and adjusted, it is always safer and much more economical to have such a plant designed and constructed by a competent heating and ventilating engineer. There is a danger of failure in after operation due to incompetent management, for which too often the designer has to take the blame. Another point which is often overlooked, is the sanitary surroundings where the fresh-air supply is to be taken. If the source is contaminated, the whole system fails in its object. On account of the difficulty in obtaining a supply of pure air near the ground in our cities, the best practice to-day draws it from the top of the building.

At the Detroit Opera House, the supply is drawn in at the second story; at our Western High School the building containing the boiler and fans is in the rear of the main building, and is one-story high. The fresh-air intake is on top of this addition. Our Central High School occupies one end of an entire square, and has plenty of air space. The intakes there are three in number, about five feet above ground level. Here again, the boilers and fans are in an addition at the rear. In our new schools the boilers are not located in the school building proper. In closing I will add,—

The concentration of population, which has taken place in our cities, during the last few years, has caused great increase in land value, and a corresponding increase in rents, thus producing overcrowding in our buildings, resulting in a demand for their better equipment in regard to sanitary matters for the protection of public health. In tenement districts we find from 4 to 8 families living in houses of as many rooms. In cheap lodging-houses, one of which I inspected last week, in company with our health officer, we found rooms opening off long, narrow halls, which were three feet wide, six feet long, and seven and one-half feet high, just large enough to set up a narrow bed, and allow a person a chance to get into it. Very few of the rooms had any windows or transoms over the doors. At the end of the halls were cheaper lodgings, consisting of nine bunks in a room six feet wide by eighteen long. In this one building over one hundred persons sleep nightly, paying from five to fifteen cents per night for the accommodation. Five cents gives a bunk without bedding, ten cents one with a filthy mattress and equally filthy cover, fifteen cents affords the luxury of one of the bed rooms. The odors from such a place can hardly be described.

This sample is quite elaborate compared with others in our so-called tenderloin district. It seems hardly credible that human beings can be found to inhabit such places, but it is true, such is life on the under side.

No better work is being done to-day than that put forth to secure by legislation a mitigation and, as far as possible, an obliteration of such foul pens.

All who make sanitary work a study admit that the decrease

in the death rate of our large cities is, in a very large measure, due to the improvement in the sanitation of our tenement districts and the enforcement of proper drainage and ventilation of our buildings. In comparing the death rates of our cities, it will be seen that the larger the city the higher the per cent, and it is in these cities that the greatest fall in the rate has taken place as a result of the enforcement of sanitary restrictions.

In conclusion I quote from an article in the New York *Medical Journal,* by its editor, Dr. G. F. Shrady: "The comparison between the death lists of 1890 and 1900 shows that in one decade, the effects of American health authorities and hygienists to lengthen the lives of our citizens have been attended with gratifying results.

"One of the surprising showings is, that the country districts have not made so much relative improvement as the cities; and in fact, the most marked improvement in the conditions of living applies only to the larger cities, due to the perfection of sewerage and water systems of such places, and the more effective inspection by competent health officers. There has been a growing tendency on the part of the American people to demand cleaner cities, the perfecting of tenement houses and all that sort of thing, and the result has been a great improvement in conditions. Diseases arising from unclean conditions are now being conquered, and their influence upon the health of the American people is less and less every day. It is not necessary to go to Havana to show that our methods are effective and conducive to health, and we are confident that the census of 1910 will make another flattering report."

USE OF THE TRUE MERIDIAN IN A RESURVEY.

E. STRONG.

THE true meridian has very little use in a resurvey. It makes an excellent guide to a random line, in the absence of all other signs. A rail fence on a quarter line, or on a section line, is, if straight, a better guide as to where the survey will finally locate the line. If the magnetic direction of neighboring lines is known, approximately, the random on corresponding lines in a fresh section will do well to follow suit.

But when all other sources of evidence fail, the true meridian will splendidly serve the purpose of a — What? A random line! I say a random line, because it is good for little else; that is, in a resurvey. And that is about all the surveying, for the subdivision of land, now wanted in the State of Michigan. Michigan statutes and courts refer to resurveys.

But neither the magnetic meridian nor the true meridian is fit to establish a line or a corner upon, in a resurvey. No provision of law allows it. No one would run a meridian line, and at the prescribed distance, set a bound for the corner to a deed, and expect to go into court and have his work recognized. At least he would try it only once. Thereafter he will throw away his true meridian, as soon as it is completed, and correct it, to any old corner that he can find, and move his stakes into the old line of the old survey, uncouth and imperfect though it be.

Thus will vanish, as a dream, his meridian line, its beauty, and the fog of its theory.

Will he throw away his meridian line? — He will. What! and after he has been to so much time and trouble to determine the true meridian at the initial point? Of course, he will if he has any horse sense left. But, sir, do you think he will really throw away his line, and make no practical use of it, after the Legislature has ordered a meridian determination, and the Supreme Court has said that his certificate and record cannot be admitted in evidence for any purpose, without such irrelevant determination? — Indeed, he will throw it. And there will be no trouble about his having lots of horse sense left after all other kinds have given out.

We sometimes hear ourselves saying, "Young man, tie your surveying to a star." From a literary view, that is all right, and has influential support. But, honestly, what use is there of his running a meridian line for a random line instead of any other random line? And why should he pretend to determine at the initial point of survey, the variation of his needle from the true meridian? He cannot do it, because he has no other way to fix it down there in the woods, except with this same needle. He objects to the needle because it contains at times all the errors of the decalogue, including lying and deceit,— a needle stealing from one man and giving to another what, perhaps, does not belong to either one; an unreliable coquette, never two days alike, nor one day alike. Indeed, the average maximum daily variation of eight new needles tested nine days by Mr. Gurley was over nine minutes (9.2½). And the average maximum daily variation from the mean was over five minutes (5.2-9). These needles were made by the same man, from the same sheet of steel. The observations were made in December of 1894 and on the same centerpin. (See "Michigan Annual" of 1895.) And yet, this instrument, this needle to which he so strongly objects, is the very thing with which he supposes himself to have set up a meridian standard in the woods, and everywhere else, where he surveys, to which all other lines that he runs are to be referred and described in his notes and records, and certified to in the register's office within thirty days.

These are foggy days, but there are other fogs. And to realize how thick the fog is, the whole process should be described. But this would take too long. There is too much of it, such as it is. So we better skip how he gets his meridian, where he found it, how many miles he carried it home, and how he fastened his needle so that it could not stir, or move, or change, in carrying the meridian. Let us suppose he has a meridian line at home, marked correctly, with no wires overhead nor within three hundred to six hundred yards.

The true meridian is a nice thing to have around, and it would be better still if he could wind it on a reel, carry it with him, set it up at the initial point, and take it down again when he goes home.

He cannot do this, not yet. And if he could and ran all his

lines by it, what good would it do in a resurvey? He would have to throw away his extra work, and correct the meridian line itself, and leave no stakes upon it whatever, for fear they would deceive some one; he has deceived himself already, and that is enough. He has waked up now, and will not stay by his true meridian, and will move over all his stakes on to the old erroneous survey. You can trust him to do that every time. No fog of the meridian will dim his sight in a resurvey.

No statute provides for setting a stake on a meridian line any more than on a magnetic line. That is curious, too, if a true meridian is such a handy thing to have and so important. Perhaps we ought not to say that the law and the courts require this when neither they nor any one else expects that it will be put to any earthly use. After it has been called down from the heavens, that is the last of it.

But the surveyor cannot carry a true meridian with him, on a reel, or on his needle, not even on a rail, nor make observations in the woods, in the daytime. He has no solar, or solar attachment, and don't want any.

But let us see what he does do, when he intends to do the best he can. He has ten or fifteen miles to go to his next work and wants to start early. So he compares his needles with the meridian mark and notes the variation, in the morning, not a week or a month beforehand, but the very day. It is a cold, damp morning, and a heavy dew, although a dry time and the September sun still stings at noon. He reaches his destination, and finds the men waiting him, and the quarrel that is on is narrated. His chainmen are selected from another section, and sworn, and as the initial point is some distance, he takes an early dinner, and it is half-past twelve or one o'clock when running his first line. So his needle has made its maximum daily change, which is nine minutes, more or less, and the meridian which is being used and recorded contains this error. What else can it be? Nine minutes, with one seventh added, equals ten links in a half mile. The maximum variation will some days be fifteen minutes and on rare occasions reach double this amount. No one can tell, now, or in the future record, what the maximum variation of that needle was, for that day. But whatever it was, it was likely to occur between morning and one o'clock. What then becomes of the

importance and reliability of referring all surveys to the true meridian if this is the way, and as the poet says, "If this is all. O Earth."

Nor is this one source of error the only one that ails this true meridian record. All the limitations of a needle instrument are reproduced in this meridian standard of excellence. The dulling of the centerpin, the sluggishness and crookedness of the needle, elevation errors, and the chronic, rickety condition of the instrument, the slides of telescope, and slack of screws all go in, to the construction of this meridian record, at the initial point. What else can it be?

I confess to seeing little or no gain over the old reference to the magnetic meridian, which is many times all right and sometimes all wrong. Indeed, this reference will simply be a cross between the two meridians, while the needle is thoroughbred, in careful hands, that will take the same time and pains that he would to fog himself and others about a meridian line, in such hands, fairly good results can be had, and a record made that will answer every purpose that ought to be expected under the facts.

We, the people, expect too much from this wonderful needle and wonderfully true meridian. Because they can do certain things we expect them to be perfect and never lie, and we are sorely distressed when we first learn that they have cruel limitations, against which we must provide; they have limits of allowed error, like everything else on this earth. Even the work and results of the instruments employed in the coast survey, for latitude and longitude have an allowed limit of error of thirty feet radius. And we need not feel disappointed if the initial point meridian record follows suit and develops about the same amount of uncertainty, as the magnetic meridian has heretofore. And future records of line directions will contain the same unknown quantities concealed, the same difficulties met in their elimination.

Yes, we expect too much of these meridians. The practical purpose of their record is very limited. They are entirely insufficient, to establish lines and corners. No surveyor attempts it, no court really wants it done. Even with fairly good practice an error of five minutes is likely in the record. And what is an error of five minutes? — More than three feet in half a mile, and

many a litigation involves less. So that this kind of meridian business is not well suited to settling lines and corners, and is outlawed even now in United States work, where a solar is required. But a solar line would have to be corrected in a resurvey and the random for correction east, west, north, or south is not given or required in the record. However, I have always made a sign for it on the diagram of the field book, and find it useful in correcting some other time, perhaps some other day, showing the amount and which way.

Perhaps some one will say, "Mr. S., the object of this meridian requirement is not to run lines by it, and set corners upon it, in any case, but to record a fuller description of the lines that are run and have been run."

But what is a record of this meridian for? If it cannot be used in setting lines, is its beauty its only excuse for existence, or is the fog worth preserving? And as to a description, a description of a line is not necessarily a description of a needle, and the latter is the thing required.

A description of a line includes a statement of the length, the general direction north, south, east, or west, or an intermediate traverse, the bounds planted at the ends, or along the line, the witnesses, and may include the angle the line makes with one of the meridians. But this is not the language of the requirement. The complied law of '97 requires the record of the allowance the surveyor makes for the variation of his needle from the true meridian, if he makes any allowance. No land surveyor makes any allowance as anybody knows, except only for the position of the United States lines and corners. And the survey is made precisely as no meridian line were known. It has just nothing at all to do with it, any more than the weather has. A rainy day cannot stop survey. And every stake and corner are left just where they would go with or without a meridian, and no allowance will be made for the variation of anybody's needle from anybody's meridian.

A description of a needle is not a description of a section line. This would require a further specification showing the variation of the lines run from one of these meridians. If the variation of the lines run was given, it would certainly describe them.

In conclusion, we must not expect too much from a record

of a survey referred to the magnetic meridian or the true meridian, either one. The latter may describe the needle alone, and give the bearing of no line whatever. It may give the angle that the line north makes and no others, and yet no others be the same. It may give the angle of the line west alone, and the corner at the initial point may be from one to sixty minutes out of square. Three other lines from the initial corner are undescribed. These deficiencies are to be added to the inherited errors of the initial point record. No device has yet been invented to overcome the very common defect of no record at all, and no bounds at all, or that will compel the indexing of scattered work. Nor can legislation sharpen a centerpin or remagnetize a needle. A true meridian line won't do this. Nor will it subtract 1-7 from the links of the random, and call it minutes of correction, to be added to the vernier reading if he strikes to the right, and subtracted if he strikes to the left.

This, within limits, will make the record answer such purpose and such purpose only as should be expected by reference to a needle standard, or to the true meridian carried for many miles and many hours on a dull and sluggish needle. Yes, and carried for many days and many months.

Ohio limits the time to thirty days. But this is only on the statute book.

The needle should be compared in the middle of the day, to fit, if possible, the time of work, and a standard mark will be eyed with suspicion at the county seat, having electric wires and power used on all sides.

If the Supreme Court would only give us a ruling that the section lines of the United States survey were the legal meridians and were to be held as the true meridian lines that they were returned to be, in the returns to the Surveyor General, and that these were the legal meridians, for subdivision of land and the ones to which the statutes and courts refer, or should refer, I think it would be the solution of an otherwise very bunglesome condition of law and facts and decisions. It would then be entirely possible to comply with what I suspect the statute originally intended to require. The friends of the statute could then claim that it was founded on reason and common sense, while now it seems to be lacking in both. I can dream of no other solution,

SOME DETAILS IN THE COST OF MACADAM ROAD-BUILDING.

F. F. ROGERS.

While I am well aware that the cost of a given road is always a local question to be determined by the prices of labor and materials in its immediate vicinity, it is equally true, that in Michigan there is a fairly uniform supply of materials within a moderate railroad haul, and the price of labor varies, only within narrow limits. Again, St. Clair County has no local stone of any consequence, and has to pay in addition to the cost of its material a freight of 40 cents per ton on cobble stones. Freight on the crushed quarry stone has thus far been about double the rate on cobbles. For this reason it seems safe to conclude that what can be done in this locality can be duplicated for the same cost in any part of Michigan having similar railroad facilities.

The items of expense in any well-built road should be: —

1. Surveys and plans.
2. Grading, including drainage and shaping.
3. Purchasing or preparing the metal.
4. Applying the metal to the road, including transportation from cars or crushers.
5. Compacting, which will consist of watering and rolling.

It has been my duty in the past few months to superintend the construction of two pieces of typical country road. There was no attempt to make these roads cheap by slighting necessary details; for they were built on account of the Port Huron E. & T. Co.'s statute labor tax, with the right to charge a good rental for all the machinery employed, yet they were built with a view to making a given amount of money cover as many lineal feet of road as is consistent with good construction.

They were built so far as possible with the machinery manufactured and sold by this company, for the purpose of determining the efficiency of this machinery in the actual work of road-building.

The following tables give the cost of the two roads: —

TABLE I. TWENTY-FOURTH STREET.

Summary of cost of macadamizing 24th Street, 9 feet wide, including the intersection of Griswold and 24th Streets, and the extras at intersections of private drives: —

Grading	$ 46 96
Delivering 326.3 cu. yds. Bay Port Stone, at $0.454 per cu. yd., part with engine and spreading wagons, and part with teams	148 10
Delivering 328.5 cu. yds. crushed cobble stone at $0.5486 per cu. yd., nearly all with spreading wagons and roller, including sprinkling and rolling	180 20
328.5 cu. yds. crushed cobble stone at $1.644 per cu. yd.	540 05
326.3 cu. yds. Bay Port Stone at $1.53 per cu. yd.	499 24
9.25 cu. yds. Bay Port screenings to redress road	13 30
Engineering	57 05
Total	$1,484 90

NOTE.— The work covered by the above cost is equivalent to 2,900 feet of road 9 feet wide, costing $0.512 per foot, or at a rate of $2,703.36 per mile.

The total depth is 8.12 inches; coarse stone is 6.01 inches deep; binder is 2.11 inches deep; 160 cubic yards of binder were used, equal to 33 per cent of the coarse stone.

TABLE II. DOVE STREET.

Summary of cost of one quarter mile of road on Dove Street, Port Huron, Mich., October and November, 1901.

Grading and turnpiking	$ 54 45
192.5 cu. yds. crushed stone at $1.586, in wagons at crusher.	305 24
58.7 cu. yds. screenings at $1.37, f. o. b. cars	30 42
Delivering crushed cobble stone with roller and spreading wagons, including sprinkling and rolling	141 98
Delivering binder with teams and spreading on street	31 49
Engineering	13 02
Total	$626 60

NOTE.— The above road is 9 feet wide; stone and binder, 6.85″ deep; hard stone (cobble), 5.35″ deep; binder (Bay Port), 1.5″ deep; binder equals 28 per cent of coarse stone; cost per mile, $2,506.40.

LAYING OUT.

The center line of 24th Street was run, and stakes set, each 100 feet, uniformly 12 feet on each side of the center line, making

the stakes 24 feet apart on a cross section of the road. Levels were taken on the center line and on each side, and a profile of the street prepared. The side ditches were in good order, and, in fact, a very well-graded road was found, so that about all of the work required was to prepare a suitable bed for the stone, and to put the shoulders in shape to hold the stone in place. No underdrains were necessary.

The stone was placed nine feet wide on the central portion of the road. The work of shaping was mostly all done with a common road grader. This was first used to cut off the high places and fill the hollows by setting the blade at right angles to the line of street, locked in position and at proper height to cut and fill to the best advantage, and used in this manner till no further good could be accomplished. The grader was now set with the blade at a slight angle, and enough earth crowded to each side of the central nine-foot strip to form suitable shoulders and make the desired crown to the bed.

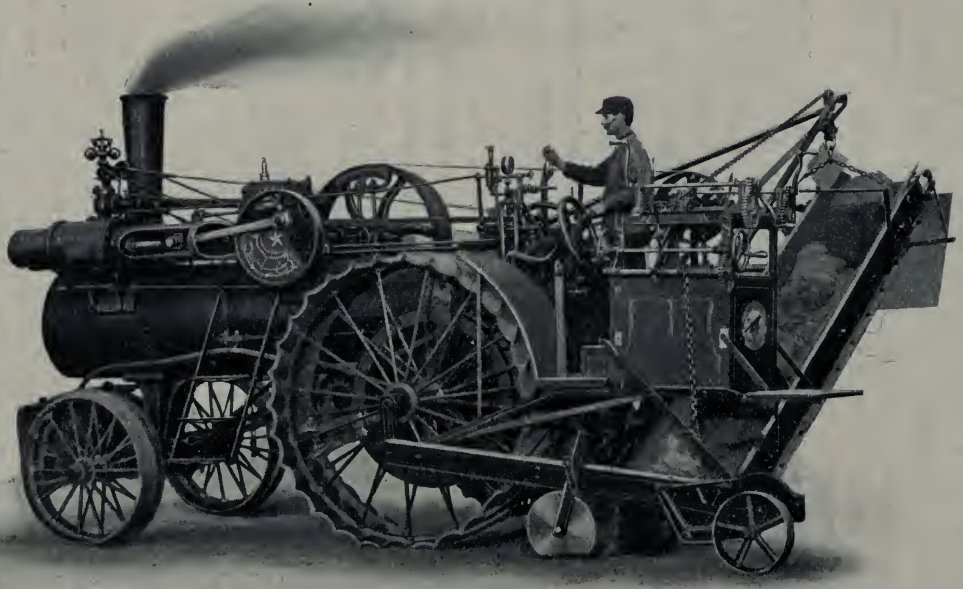
During the operation of the grader, stakes were set parallel to the center line, and 11 feet apart in cross section, thus placing them one foot outside of the central nine-foot strip and on each side. This will be found a great convenience in holding the grader to line, and the stakes will not be destroyed till the grading is completed and the rolling begins.

The edges of the bed were afterward trimmed to line with shovels, and the crown corrected wherever it was needed. During the hand trimming, the roller was passed back and forth over the subgrade, and the trimming process continued till a well-shaped and well-compacted subgrade was produced.

The surveys for Dove Street were reduced to a minimum. Recently plotted plots defined the side lines so that a tape line and some pickets were all that was needed to mark out the proposed bed. The land was very level, so that the only instrument work done was to set grade stakes for trimming the bottom of the ditches. About 700 feet of this street, however, was broken up and newly piked, and a very good grade made, thoroughly harrowed and rolled down with steam roller.

APPLYING THE STONE.

I will now confine myself to 24th Street, the only difference being, that Dove Street consists entirely of crushed cobble stones



GRADER AT WORK.

with limestone binder, while 24th Street has a lower course of quarry limestone and a top course of crushed cobble stones, all bound in with screenings from crushed cobble stones, so as to avoid dust as much as possible.

The bottom course of 24th Street, to a depth of thirty-six one-hundredths of a foot before compacting was made of crushed limestone from Bay Port quarries. This was delivered to the street from the cars, partly with spreading wagons and engines, at a cost shown by the table, of a little more than 45c per cubic yard. This cost includes spreading, but not rolling.

The stone was rather fine, in fact, much of it too fine, and no binder was used in this course. It was rolled so as to compact as much as possible before the top course was applied.

CRUSHED COBBLE STONES.

The top course was of crushed cobble stones, and one of the objects of this paper is to show that, even where stone must be freighted to the road, it is possible to crush them at a cost that will make country roads possible, and even bring this desirable class of road material into sharp competition with limestones furnished by the Michigan quarries.

The two following tables will show the cost of crushing cobble stones at Port Huron in 1901:—

TABLE I.

Cost of Crushing Cobble Stones, Port Huron, Mich., July and August, 1901.

Date	Hrs. run	Yds. crushed	Labor cost	Rental cost	Fuel oil-ref.	Total cost	Cost per. yd.	Remarks
July								
8&9	17.5	100.5	$27.60	$12.00	$4.00	$43.60	$.43–	
10	7.5	38.5	11.50	6.00	2.00	19.50	.50	
11	10	73	14.50	6.00	2.00	22.50	.30	
12	10	61	16.63	6.00	2.00	24.63	.404	These stone were
13	10	57	15.00	6.00	2.00	23.00	.40	crushed for
15	10	57	12.75	6.00	2.00	20.75	.364	24th Street city
16	10	56	12.60	6.00	2.00	20.60	.367	contract.
Aug.								
3	10	62	13.90	6.00	2.00	21.90	.35	
4	5.5	47	6.72	6.00	2.00	14.72	.313	
7	8	50	10.05	6.00	2.00	18.05	.36	
8	10	58	13.15	6 co	2.00	21.15	.364	
9	5	46	9.52	6.00	2.00	17.52	.38	
13	8.5	48	15.07	6.00	2.00	23.07	.48	
15	10	56	10.45	7.00	2.00	19.45	.347	Tank charged at
16	10	47	9.55	7.00	2.00	18.55	.39	$1.00 per day
17	10	62	11.80	7.00	2.00	20.80	.335	from this date.
19	9.5	56	11.83	7.00	2.00	20.83	.37	
20	10	41	8.50	7.00	2.00	17.50	.426	
23	10	64	10.96	7.00	2.00	19.96	.312	
25	10	65	12.00	7.00	2.00	21.00	.32	
Totals	171.5	1145	$254.08	$133.00	$42.00	$429.08		

LOADING TRAIN WITH CRUSHED STONE.

Average number of yds. crushed per hour, 6.67; average rental cost per yd. for crushing, $0.125; total average cost per yd. for crushing, $0.375; average labor cost per yd. for crushing, including fuel, oil, and repairs, $0.25.

TABLE II.

Cost of Crushing Cobble Stones, Port Huron, Mich., October and November, 1901, for 24th and Dove Streets.

Date	Hrs. run	Yds. crushed	Cost Labor	Rental Cost	Fuel oil-rep.	Total cost	Cost per. yd.	Remarks.
Oct.								
14	5	20	$16.88	$7.00	$3.00	$26.88	$1.344—	Broke cap.
15	10	64	12.25	7.00	4.00	23.25	.363	
16	3	13	5.95	0.00	0.00	5.95	.458—	Broke casting below cap on main shaft.
21	10	33	16.70	7.00	3.00	26.70	.81	
22	10	79	16.75	7.00	3.00	26.75	.339	
25	7	47	12.10	7.00	3.00	22.10	.47	
26	10	55	16.40	7.00	3.00	26.40	.48	
28	10	56	13.90	7.00	3.00	23.90	.427	
29	5	34	7.43	7.00	3.00	17.43	.51	Broke cap.
Nov.								
1	3	8⅓	4.48	7.00	3.00	14.48	1.74—	Broke casting below cap on main shaft.
4	3	15	4.50	7.00	3.00	14.50	.966	
5	8	44⅔	9.73	7.00	3.00	19.73	.44	
6	10	53	8.57	7.00	3.00	18.57	.35	
Totals	94	522	$145.64	$84.00	$37.00	$266.64		

Average number yds. crushed per hour, 5.55; average rental cost per yd. for crushing, 16c; total average cost per yd. for crushing, 51.08c; average labor cost per yd. for crushing, including fuel, oil, and repairs, 35c; total number of cords of stone crushed, 91.5, yielding 522 cu. yds. of crushed stone, or 5.7 cu. yds. per cord, the stone being measured in three separate grades as it came from the crusher.

NOTE.— The crushing cost above tabulated is unduly large, owing to the fact that four bad breaks to the crusher occurred, causing a considerable loss of time. It will be noted that on three separate days the crusher ran only three hours per day, on two days only five hours per day, on two other days five and seven hours each per day, and on one other day eight hours, but full rental is allowed for the crusher on all of the above-mentioned days, except one.

You will note that in July and August, our labor cost of crushing was but 25 cents per cu. yd., while in October and November it reached as high as 35 cents, the latter high cost being due to a very unfortunate series of breakdowns. (We do

Tram on the Road.

not build a crusher.) There were some breaks in the summer, but no doubt that may be considered a normal run, as some breaks are unavoidable.

The total crushing cost, according to these figures, including rental of machinery, is rather high, yet one can see that crushed cobble stones, costing $6 per cord at the crusher, may be used and not cost much more than crushed limestone from the quarries. In making comparison, one must remember that stone in the crusher bins can be loaded into wagons for 6 or 7 cents per cu. yd. less than the cost of shoveling from the cars.

THEORETICAL COST.

We will assume that a suitable crushing outfit of the same capacity as the one used in this trial can be bought for $1,500.

As the good-sized rental figures into the above cost, I can see no reason why the following is not a fair method of figuring, for a contractor who owns the machinery.

Allowing that 100 days is an average year's work, we have a depreciation per running day of $2.40.

We then have interest on $1,500 for one year at 6 per cent..	$ 90 00
The machinery should last ten years, making depreciation per year 10 per cent, or.....	150 00
Giving total machinery cost per year.....	$240 00

From the crushing tables we learn that the average crushing rate per hour for all the stone crushed was 6.28 cubic yards. We will call it 6 yds., and 60 yds. a day's crushing, thus making the cost per yard for interest and depreciation of machinery 4 cts.

Again referring to table for July and August, we have, as labor cost including fuel, oil, and repairs, 25 cts. per yard.

To arrive at a suitable average material cost, we will assume that cobble stones can be delivered at the crusher for $5 per cord. Crushing table No. 4, accompanying this paper, shows that in a run of nine and one-half cords, the crushed stone per cord of cobbles amounted to five and seven-tenths cubic yards, or an increase in bulk of 20 per cent. The stone was measured in three grades; viz., as screenings, one and one-half inch, and two-inch stone. All stone that passed over the two and one-half inch section of the screen were returned to the crusher by a carrier

SPREADING STONE ON THE ROAD.

devised for that purpose. Figuring on that basis, each cubic yard of stone at the crusher before crushing, cost 88 cents. We now will have the complete cost per cubic yard of stone in the bins of the crusher as follows:—

Machinery cost, being interest and depreciation	$0 04
Labor cost, including fuel, oil, and repairs	25
Cost of stone per yard	88
Total cost	$1 17

Taking into account the ease with which stone from the crusher bins are loaded to wagons, we consider this price as good as $1.10 per cubic yard F. O. B. cars on a railroad siding the same distance from the road as is the crusher.

While it is probably true that we seldom or never can realize 100 per cent on our theories when put into actual service, I wish to apologize for some of our figures, and offer another hypothetical case. The cost between the stone on the car or bins of crusher and the finished road will always be large at best, and some of the items cannot be much further reduced in cost.

When it must be unloaded from cars, this could be very much reduced by specially designed cars that could be dumped from the bottom, but as the amount of material used from one siding will always be comparatively small, it would probably not be profitable to put up the necessary trestle on which to place the cars for the purpose of unloading. Again, suitable power required to place the loaded cars and remove the empties would not always be available, without the constant use of a switch engine which in turn would raise the cost more than enough to offset the savings sought.

If before cars were loaded, inclined planks were placed in one or both ends, reaching from the floor to points above the level of the stone, a ready means of starting the shovelers would be afforded, and in a measure the laborious process of "breaking down," which takes a considerable time with every car, would be avoided.

As the total cost of this labor, including compacting, ranges from nearly 50 cts. to over 70 cts. per cubic yard in the tables shown, a considerable percentage of which is due to spreading,

ROLLER AT WORK ON THE STONE.

watering, and rolling, a saving should be effected along all of these lines. We are seeking to reduce the hauling and spreading charge by using the roller as a traction engine in place of horses, and large wagons that spread the stone to any desired depth. We have reduced the rolling charge by delivering the stone with the roller and broad-tired wagons, but the sprinkling charge has not been reduced. Wet weather can often be taken advantage of in country road building, and as much rolling as possible done when the weather is most favorable.

In these tables the hauling charge is high, owing to the fixed rental charge of $2 per day for each wagon, and $5 per day for the roller, not including fuel and labor, whether they could be kept fully employed or not. This would not be true with a contractor owning his machinery, and controlling more fully the conditions than it was possible for me to do at that time. The machinery would be more constantly employed, and we would only figure it, getting cost, interest, and depreciation on the investment as above outlined.

On October 22 (see table), 79 yards of stone were crushed, and 76 yards of this were delivered to the street, a distance of three quarters of a mile from crusher, with 1 roller and 5 wagons.

We will suppose that a roller and five wagons are required for an outfit at a cost of $2,500.

Interest on $2,500 at 6 per cent	$150 00
Depreciation at 10 per cent	250 00
Total machinery cost per year	$400 00

Again, taking one hundred days as the working season, we have,—

Working cost, at $4.00 per day	$4 00
Labor cost per day for engineer	2 00
Helper on train	1 50
Fuel and incidentals	2 00
Total cost per day	$9 50

Allowing that 76 yards can be delivered per day, we have here total cost of 13 cts. per yard for hauling and spreading. The man who dumps the wagons can keep the street well trimmed at all times.

A Section of Completed Road.

To deliver the same with teams would require 5 teams, at $3.50. $17 50
Two men on road to help dump and spread, at $1.50..... 3 00

Total per day.....$20 50
Or 27 cents per cubic yard to spread on road by common methods.

While the prices that can be obtained from the foregoing tables do not show any such results, nor even figures that I do not think could be duplicated and even reduced by team hauling, the examples above referred to show some of the possibilities within our reach.

Just what percentage of rolling can be credited to this method of hauling and applying the material to the road is not determined, but the photographs you now see prove clearly that it is no small help toward the final consolidation of the road.

I must confess that these figures are not as satisfactory as those I was in hopes to be able to show you, when I took charge of these roads, and under better conditions, with all the details under my control, I shall hope to be able to report a completed road, built in this manner at a small percentage above the theoretical cost, which I truly believe it is possible to reach.

WATER COST AND WATER WASTE.

A. L. HOLMES.

In the water plants of this State, the different modes of getting the supplies, and the sources from which water is obtained, will show a little difference in the cost to deliver a thousand gallons to consumers in different towns.

At Ishpeming, for instance, a short line from an elevated lake a couple of miles from town, delivered by gravity the water under about forty-pounds pressure to the lower part of the city, and fire service is furnished the city by a pumping plant, using the conduit line for a suction pipe. This pipe line, costing about $50,000, has supplied this town for a dozen years, and ten thousand consumers have had cheap water.

The yearly cost of pumping has been about $300, and until the past year no attempt has been made to restrict the waste that has well-nigh ruined the efficiency of the plant, and dropped the pressure in the mains from forty-five pounds to one half of that in the business part of the town.

In many of the towns using about one to two million gallons daily, I find a record of about $5.50 to $6.50 per million gallons for fuel, pumping generally against about 100 feet of elevation.

The cost of water delivered into the mains in the city of Grand Rapids, taking the report of the board of public works for 1900 as authority, was about four and one-quarter cents per one thousand gallons, and the water department received for the year's pumping, $109,981.53, or about two and one-half cents per one thousand gallons.

The cost of fuel for pumping was $4.08 per million gallons.

In Kalamazoo, the cost of pumping a million and a quarter gallons per day last year was, for fuel, an average of $6.72, or at the rate of $5.50 per million.

In towns using an average of half a million gallons or less per day, and with a population of 2,500 to 5,000, the cost will be double the amounts already given per million gallons, and in

many towns with old pumps and boilers and poor attendants this may be again doubled.

Where the consumption reaches half a million or more, and standpipe or reservoir can be utilized, compound pumps will lower the cost considerably.

Again, we come to the natural gas region of Indiana and Ohio, and find many of the plants with their own gas wells, using compressed air, and delivering water to consumers as cheaply as is done by gravity plants.

These gas reservoirs have been largely exhausted, and these towns must now turn to other sources of power.

There is a great deal to be said in favor of gas and gasoline engines for the pumping of water in smaller cities where the fuel must be purchased.

Low cost of construction and minimum cost of maintenance are desirable features of this form of power.

But to get at the cost of water delivered by our water plants, we have other items besides fuel consumption to reckon with.

First comes location, right of way, and construction generally met by bonding, and the interest charge must be met yearly or semiannually.

Second, a sinking fund sufficient to extinguish the debt in twenty years should be provided for. Then comes maintenance, operation, and depreciation, the latter item of which may be largely cared for in the yearly repair account under intelligent management.

This leaves the pipe-line extension to be made in the same manner as the original plant was built, which is proper, but not always practicable; and they are often cared for from the water revenues, and the sinking fund unprovided for.

In many cases the interest on the bonded plant is paid by the city at large in lieu of hydrant rental, and as one about offsets the other, no great injustice is done.

There are few among our smaller plants that can afford to sell water for less than fifteen cents per thousand gallons.

Some of the engineers in charge of the planning and constructing of waterworks plants seem to have lost sight of the financial part of the transaction, as it relates to the future operation of the works, and the idea of receiving more money for water sold than

it costs the municipality seems never to have occurred to them. Evidently they look at waterworks management as they do at the handling of the police force or the fire departments, and entirely forget that the municipal water departments are attempting to collect sufficient revenue from consumers to care for the investment and cost of operating the plant.

We plan and build works almost regardless of expense in construction that the economy may be in many years of low cost of operation. We install triple expansion engines and water tube boilers and the highest-grade and highest-priced pumps that we may keep down the fuel bills.

In gravity lines we go long distances to secure the required elevation, and invest large sums in conduits of great size to save coal bills. We put in extensive filter plants, and try to purify the water that man has contaminated, and again we pile up a bonded interest-bearing debt for the next generation to meet.

In all these points we consider it necessary to look up very closely the most economical means to elevate water or to deliver it under pressure to the consumer; and the engineer must plan and build, but some may contend that it hardly belongs to him to barter and sell water.

But in this strenuous time many engineers are looking to the care and operation of water and light plants as a source of sustenance, and I see no reason why an engineer cannot become a good business man. Evidently Brother Skeels does not believe that way: for his advice to a young married member of this society was that, if any of his sons evinced any disposition to become an engineer, to drown him in the cistern at once.

The manner of *attempting* to set a price on a commodity the amount of which we are in ignorance of, is about as hard a problem as can be placed before any waterworks superintendent.

The fact is that we don't sell the water at all, for we don't know how much is used, but we lease the right to handle the faucet at the consumer's own sweet will.

The cost of reasonably pure water suitable for domestic use will increase in our municipalities for some time to come, and the reason is quite obvious; for there is urgent need of changing half of the plants in use to-day; few have a quality of water safe or satisfactory.

What I call a new "water end," which means a new location and source of supply with new and modern machinery, large intakes, and force mains to strengthen the present piping systems for fire service, is the need of more than fifty per cent of the waterworks in this country. These new extensions and changes will generally cost as much as, or more than, the original plant, and the large bonded issue, with its annual interest charge necessary to carry on the work, will materially increase the cost of water to the town.

Filtration is rapidly coming to many of our cities, and this will in many cases double the cost of water to the producer.

As the accepted system of operating the municipal plants is for the consumer to pay for the cost of operation and maintenance, ought not that cost to be brought by the management in the interest of the consumers to the lowest possible point?

As I have said, the price of water for domestic uses must increase to the producer, and unless the waste, which equals one half of the pumping, is stopped very largely, the schedule rates must be increased to pay the expenses of operating.

The plant in Grand Rapids was built nearly thirty years ago, and has not received as much from the sale of water in that time as the plant has cost, allowing the interest paid to offset the cost of hydrant rental; and now there faces the city the expenditure of at least a million dollars for a pure water supply and proper distribution system. When we have a plant properly constructed, and in condition to do business with a good supply of water of fair quality, which consumers *must* have, and delivers it under a pressure that makes it available for all purposes, then it becomes very necessary that we receive pay in proportion to the water supplied to the consumer.

There is only one way by which this can be done, and there is no plant that can operate on a hit-and-miss schedule rate, and receive income enough to make the plant self-supporting from water alone. But when the plant is operated on a meter basis, and the parties who use the water pay a fair price for it, with a reasonable minimum charge to secure the use of enough water for sanitary purposes, then the waterworks system passes from an uncertainty to a profitable enterprise, and the benefits of our installation of coal-saving devices are secured.

We can then control and regulate the enormous waste that has bankrupted many of the franchise plants, and forced the most of the municipal plants to depend for their supplies upon foul and contaminated streams.

I think it will not be out of place to quote here from the reports made by the officers in charge of some water plants that have tried the meter plan for the sale of water.

The water commissioner, Mr. George Houston, of Kalamazoo, in his last annual report, says: "I am greatly pleased to call your attention to the fact that the records for the year 1893 show that the daily pumpage of water amounted to 2,150,000 gallons, while for the year just passed (1900), only 1,223,000 were pumped, or a decrease of 927,000 gallons daily, while the population of the city has materially increased (and over 300 services have been added since 1893, an increase of more than ten per cent).

"The great decrease is undoubtedly due to the use of meters placed since 1893."

"There were 83,336,727 (or 15.7 per cent) less gallons pumped during the past year than the year before, which undoubtedly represents about the amount of water let run to waste to prevent pipes from freezing during the previous year,"— there were sixty-eight new services put in last year.

It is also a noteworthy fact that no complaint has been made during the past winter about the Vine Street sewer overflowing, as was the former rule, and no doubt, as suggested in my former report, the said sewer will now be found large enough for years to come, providing all places having sewer connections are required to be metered.

I wish now to quote history, as taken from the reports of the Board of Public Works of Grand Rapids for the year ending April 30, 1900: —

"Reference to the secretary's report will show that the cost of maintenance and operating the waterworks system for the year was — $48,083.01

Interest and exchange..... 39,261.96

$87,344.97

"The surplus income was expended in the extension and relay-

ing of mains, and in the purchase and setting of meters. Much more could be profitably expended in these lines, but it has not been deemed expedient to ask the Council to issue bonds or levy a tax for these purposes."

"It is deemed advisable to increase the number of meters as rapidly as possible, because it has been found impracticable to stop waste and leakage in any other manner, and schedule rates cannot be arranged to be just to all consumers. Many pay less than they did by schedule rate, and the aggregate receipts from metered water may be little more than was received from scheduled rates for the small consumers, but it is certain that they effect a decrease in the waste.

"That there is an enormous waste, is apparent from comparison of the amounts of water pumped with the receipts and number of consumers."

"The receipts are lower in proportion to the water pumped than in any city with which we exchange reports.

"A million gallons of water at three and one-half cents per hundred cubic feet, which is the present minimum meter rate, is worth $46.67.

"To pump an average of twelve million gallons per day and sell it at the lowest metered rate, would make the gross income $204,400 per year."

Estimating the plant at $1,200,000, the cost of maintenance $50,000, interest five per cent, $60,000, taxes at one and one-half per cent, $18,000, and depreciation at five per cent, will show that the income must be increased to $186,653 before the plant can be considered as permanently self-sustaining.

If the rate of increase made during the past year can be maintained for two years, the income will be over $190,000, and it is believed it can be done if the department can obtain a fair compensation for water furnished to schools, parks, cemeteries, and fire hydrants.

I will also quote from the report of the same board made a year later, or last May, 1901. In part they say: —

"The buying and setting of additional meters would also prove profitable to the department in the way of stopping waste, and thus save fuel by decreasing the amount of water necessary to supply the demand, as is plainly shown by the following statement: —

"The daily average amount of water pumped in four weeks, ending April 26, 1899, was 13,479,088 gallons.

"During the succeeding year, 618 meters were installed, and in the four weeks ending April 24, 1900, the daily average of water pumped was 11,858,802 gallons, a decrease of 1,620,826 gallons per day.

"During the past year, 910 meters have been set, making the total number set 2,103. During the four weeks ending April 5, 1901, the daily average water pumped was 9,724,550 gallons, or 2,134,252 gallons less than last year, and 3,754,836 less than the corresponding four weeks in 1899.

"The reduction in amount of water pumped not only reduces the coal bill, but relieves the strain on the pumping machinery that existed a year or two ago.

"If the setting of meters can be continued, it will soon be practicable to do all the pumping with one pump, except in times of extraordinary consumption of water.

"Even now the Nordberg pump could supply the demand if it were connected with the high service, and the Holly pump could be held in reserve.

"Thus it will be seen that if the board can continue to buy and set meters, there will be no necessity for buying an additional pump in the immediate future.

"The board is of the opinion that it would be profitable to set at least two thousand meters during the coming year."

This language by the Board of Public Works in 1901 is in striking contrast to the agitation in this same board previous to 1899 for a new twenty-million-gallon pump; and the facts were then shown that the pumping was increasing at the rate of about twelve per cent yearly, and that the machinery was then taxed to a dangerous degree at certain times of the day for domestic service. All sorts of dire disaster were predicted by some members of the board, and by the engineer in charge of the plant, if there was delay in making the purchase, thereby incurring the expense of about $70,000 for an outfit to consume more fuel, and increasing the cost of maintenance and operation without increase of revenue, or giving more people water service.

From the extracts that I have read from the report of the Board of Public Works of Grand Rapids, you will see that in

1893, when the city had 7,745 services and 457 meters, the daily average pumping was 12,702,763 gallons, or more than one million gallons each day more than in 1901, when there were 10,548 services, or about thirty per cent more than in 1898.

There is another way to look at this question. From the business standpoint, and leaving theory out of the question, we find that the collections for water last year were $109,981.53, and the total pumpage was 4,312,831,988 gallons, or at the rate of about two and one-half cents per 1,000 gallons.

The report of the Board of Public Works for 1900 says that to make the plant self-sustaining, the revenue must be $186,000.

It has been pretty well proved by actual trial in cities generally metered that 600 gallons per tap per day is the consumption, and you will see that in the list of twelve cities I have given the metered towns are below that figure, and I think all will rate as manufacturing cities.

Applying the same proposition to Grand Rapids, we find that its 10,548 taps, together with the water used for public and other purposes, would amount to 6,328,000 gallons daily; and if the 328,000 gallons are allowed for leaks in mains and for public uses, and the six millions sold at the present meter rate, six cents per thousand gallons, that the yearly income would be $131,400 instead of $109,981.53, as last year; or, stating it differently, the water department received pay for a daily pumping of 5,022,000 gallons at six cents per thousand gallons; there were pumped during the year 4,312,839,988 gallons, according to the pumping counters; and there were paid for during the same time 1,833,080,000 gallons.

The fact is, that all above the sum of 5,000,000 gallons is wasted, and the most of this waste can be stopped under a meter system; this will bring an increase of revenue to the city, a large decrease in the coal consumption, and reduced expenses of operation, still treating all consumers with justice and equity.

The question of a supply of pure water, either procured from the ground or filtered, is then very much simplified, and brought within the reach of the city. Other cities larger than Grand Rapids are stopping this waste, and it seems almost incredible that people who are taxed to maintain plants like this with its output of Grand River water, do not insist on stopping this useless waste, or insist on the waster paying for it.

I also wish to quote from the annual report of the city of Fremont, Ohio, dated May 1, 1901. The trustees say: —

"We call your attention to the fact that the earnings are over $3,000 more than last year (a gain of thirty per cent), and the advance in receipts is due to the placing of ninety-five meters, from which we have had the revenue for the last six months of the year.

"The amount of water pumped the last six months of the year has been reduced more than one half.

"The amount of coal consumed has been reduced from five tons every twenty-four hours to two tons.

"The testing of the water wells has proved that they will produce one-half million gallons every twenty-four hours; and when all services are metered, it will not require to exceed 750,000 gallons every day to supply the demand. With a few more wells the city would be supplied with pure well water.

"Unless every tap were metered, it would be the height of folly to attempt to keep up the supply, as the leaks and waste would be carefully attended to by the consumers if metered; whereas, if not metered, the leaks and waste would continue."

Of course, the question of cost of metering a city comes up, and as, in the nature of things, cities cannot have a surplus of money in their water department for the purchase of meters, it is often asked me how this can be done.

The first thing necessary with the management is to know that they need and want meters, and then it is very essential that they have a good stiff backbone; for interested persons who own leaky plumbing and have use for more water than they have paid for, will not submit to correction without a vigorous kick, and in many cases they can induce aldermen and those who are able to influence officials to help them kick. If they have this nerve, and are bound to bring the pumping to approximately the amount paid for, they can place meters on the services in the same manner that most of the cities lay water-pipe extensions, from the revenues. Cities can find means to put in pipe extensions, many of them in regions so sparsely settled that the inference might be that real-estate agents were more interested in the sale of lots than they were in increasing the revenue from the sale of water.

While many cities compel the water users to pay for the meters in advance, as does Milwaukee, Rochester, N. Y., and Kalamazoo, I think an easier way, and one that creates less friction, is for the city to own and set the meters and to keep them in repair, charging such rates as is necessary for water and covering the meter expenses and cost in this manner.

When you meter a system of waterworks, you secure a complete control of the output, and can place the rates where the revenues will pay the plant's expenses; it will not only pay for the meters, but will furnish means to buy pumps and pipe lines as well.

Of course, we all realize that the consumers of water pay for the meters any way you manage it; but if he pays for it in water rates, the same as he pays for the mains and fire hydrants, he does not notice it as he does if he planks down $15 in advance.

In Chicago, it costs the consumer $50 to get a meter set on his premises, while $18 is the price in Milwaukee that the plumber extracts from the householder for a meter set in the basement.

In many small cities, meters are set in basements at about a dollar each, and in Ft. Wayne, Ind., the cost is less than that amount.

Battle Creek's engineer in charge of the water department takes a good deal of pains to have meters set in a brick well below the cellar bottom, and reports the cost of setting them at $3 each.

The meter system is universally acknowledged as the only means by which the waste of water can be controlled, and there has been enough written on the subject to exhaust the arguments, and it seems to us superfluous to reiterate the stories of what can be done for crippled plants by the change from a guess rate to a payment for what is delivered; but when one finds a quarter of the waterworks plants with no counters upon the pumps, and not over five per cent with recording or vacuum gauges, many of them where no one seems certain of the number of taps in use, and where no record is kept of daily fuel consumption or water pumped, where there is no means of knowing what efficiency is secured from the fuel used, and many other un-

businesslike ways of *not* doing things, it seems as if we must yet do much exhorting in this line.

I know a good old soul who has charge of a plant having no counters on the pumps, but who *has* sixteen meters on nine hundred services, and he tests these meters for accuracy by attaching them to a piece of hose connected with his yard hydrant. When he gets this hitched up, he turns on the water; and if the meter test hand shows that the meter runs, he pronounces it accurate.

In many of our cities the pipe lines are offering too much friction resistance for the amount of water we are attempting to force through them, and the cry goes up on all sides that larger lines must be laid.

Well, if we cut off this waste and reduce our pumping by one half, don't we double the size of our pipes and increase the carrying capacity of them?

The engineers have planned and built on the theory that fifty gallons per head was an ample supply; but this waste has grown until while the fifty gallons cover the amount paid for, the consumer has delivered to him about two hundred gallons.

In the endeavor to furnish cheap water for elevators, small manufactories, fans, etc., we have gone into a field that would better be left to the electrician.

I believe in getting the purest water available, keeping it in clean reservoirs, and delivering it to the consumers in this same healthy state. I would have the supply ample, the storage sufficient beyond any question, and I would deliver it to the user at as near the cost price as safety would permit. I would make that consumer responsible for the leaks and wastes in his plumbing, delivering the water to his property line, where I would measure it, and treating him as he is treated in all other business lines — ask him to pay his share for the support of this system.

There is little opposition among the people for whose opinion one may care, to the meter system of regulating waste; for when we find a water consumer that objects to paying for the water used, that is about the place a meter should be placed.

The first object of setting meters is to stop waste, and if incidentally they allow us to regulate the revenue, and give equity and justice between the water company and the consumer, we cannot object to that.

I know that *any* water plant can be made self-sustaining, and can supply its patrons with water that is not deleterious to health in a sufficient quantity if the business is managed in a business way. The waste is so much in our plants that to those unaccustomed to these investigations, the story seems like a fairy tale, and people will not believe that such results can be obtained by the regulation of the output.

I might go on piling up facts and evidence, but think enough has been said to convince the thoughtful listener, that *here* is a field for investigation and effort for the best good of all.

AMOUNT PER TAP OF WATER USED IN 12 METERED CITIES, ALSO RESULTS IN 3 UNMETERED ONES.

Population	No.	CITY	Metered %	Taps	Per Tap
65,000	1	Atlanta	92	9,300	587
29,000	2	Atlantic City	80	4,250	538
62,000	3	Des Moines	60	7,500	400
85,000	4	Dayton	50	12,000	440
30,000	5	Racine	25	5,000	280
104,000	6	Fall River	95	7,000	548
187,000	7	Providence	83	22,000	470
56,000	8	Utica	97	7,000	425
57,000	9	Lawrence	75	6,000	541
33,000	10	Newton	85	7,000	295
125,000	11	Saint Paul	30	17,000	490
113,000	12	Worcester	95	13,000	596
87,000	13	Grand Rapids	20	10,500	1,200
35,000	14	South Bend	5	5,000	1,250
65.000	15	Saginaw	3	5,000	1,500

THE ST. CLAIR FLATS SURVEY.

This survey was authorized by an act of the Legislature in March, 1899. This act was passed in an endeavor to settle the boundaries of land claimed by various parties on the Flats. There had been more or less contention for a long time, and during the preceding ten years these contentions had resulted in demonstrations of a violent character. To prevent any further outbreaks, the Legislature took the matter in hand, and passed this act. Before the titles could be passed upon and the disputes settled, a survey was necessary. This survey is provided for in the act itself.

The survey was placed in the hands of the Commissioner of the State Land Office, who at that time was the Hon. Wm. A. French. At his request I undertook the direction of this survey. I suggested to him the propriety of hearing and taking down every claimant's story before proceeding to mark the boundaries of the claims on the ground. This proved to be a very essential element in carrying on this work. On the South Channel there are some six hundred lots and some four hundred claims; it is doubtful if there will be four contests. This will indicate the success of our endeavors to ascertain what the claimants desired, and to use our best endeavors to realize those desires on the ground. It may be said that this act was a friendly act and not an act hostile to the people of the Flats.

We found it necessary to subsist our own men and to live on quarter-boats which could be moved from place to place as occasion required. These quarter-boats, except one which was built for the purpose, were simply lumber lighters upon which were erected cheap deck houses, divided into rooms for the purposes of our work,— offices, drawing-rooms, store rooms, kitchen, dining room, sleeping quarters for the men. These quarter-boats drew about a foot or fourteen inches of water, and could be floated almost anywhere we needed to go. Besides these quarter-boats we used small boats, commonly flat bottomed skiffs, and gasoline launches for getting around from place to place.

The territory covered by this survey is seven or eight miles in breadth each way, and embraces the land within the delta of the St. Clair River. This is a genuine delta in the same sense that the delta at the mouth of the Mississippi is. It is mentioned as a remarkable fact by Prof. Israel C. Russell of the University of Michigan, that a delta should be found in so short a stream connecting two large bodies of water like Lake Huron and Lake St. Clair. In the seven or eight miles down stream, the land falls perhaps ten feet, quite gradually and quite evenly. At the head of the delta the land is three or four feet above the water, and at the outlets of the river it may be four or five feet beneath the water. We were obliged to provide ourselves with apparatus for making surveys on dry ground, in marshes, in a little water, and in water of all depths up to five or six feet.

This survey was of such a nature that it was necessary to set up a transit instrument rather oftener than would be required in plotting out lands for a city. For this purpose a triangular trestle was used, made of ordinary iron pipe and the fittings commonly found in every pipe shop. This trestle consisted of three upright legs with horizontal bars made of the same pipe about every three feet in height. It was made in two sections, roughly three feet high, so that when one section was used, work could be done in water about three feet deep; when two sections were used, work could be done in water five or even six feet deep. At the bottom of the upright legs were placed steel points, made by welding a piece of steel into the open end of short pieces of the same pipe, these points being about eighteen inches long. Before they were screwed on some common floor, plates were screwed to the bottom of the legs. The points were for the purpose of being sunk into mud, or earth, or sand in the bottom of the lake, and the floor plates were for the purpose of keeping the trestle from sinking too deeply into the soft ground. In each length, or each story of the trestle, as it might be called, and on each of the legs, was placed a common reducer. These reducers were bored out at the small end, so as to slide freely on the iron legs. They are placed on each upright of the trestle, in each story, large end up, so as to form cups for feet of tripod to set in. Two holes are bored near the upper edge, into which the ends of lanyards are tied, the lanyards passing over a bar at the

top of the trestle, so that these cups formed of reducers, could not get out of reach. In the lower end of the reducer, a horizontal hole was bored, and a thumb screw inserted. By means of this screw the reducer could be clamped to the leg of the trestle at any place.

After the trestle was set in the bottom of the lake, these cup-shaped reducers were brought at or near the surface of the water and clamped. Into the up-turned cups were placed the legs of the tripod. The metal shoes commonly found at the bottom of the tripod legs were taken off and the wooden leg set into the cup. If the plumb bob of the transit did not hang exactly over the mark, one or more of these cup-shaped reducers could be raised or lowered by means of the set screws, so as to vary the setting of the tripod, exactly as the ends of the tripod legs are shifted in the ground. The final setting of the plumb bob over the mark was made by the shifting center in common use.

For the transit man to stand upon, what were called transit scows, were provided. These scows consisted of two small scows four feet wide, twelve feet long, and fourteen inches deep, placed four feet apart, a deck nailed over both scows, leaving an opening four feet square in the center. Thus the deck of the scow was twelve feet square, and the transit man had an area four feet wide around the central hole to walk around his instrument upon. One or two extra boards were kept on these scows to be shoved between the tripod legs after the transit was set up to enable the transit man to step up closer to his instrument. At each corner of these scows was placed an oak spud 4 x 4 inches and 12 feet long. At the top of these spuds an opening was cut 1½ inches wide, and coming down from the top of the spud 8 inches. As the spuds were set, these openings were parallel to the side of the small 4 x 12 foot scows. In these openings a common 1¼ inches by 8 inches by 14 feet plank laid. Two holes were bored in these planks, one near each end, so that these holes would come just between the spuds. Into these holes were put two wooden pins to keep the planks from sliding endwise. To the planks were attached a block and tackle which pulled on some wire loops fastened to the plank sides of the scows before mentioned. When the spuds were let down, sufficient strain was put on the tackles, of which there were four, one near each

corner of the scow, to raise the whole scow partly out of the water. It was not found necessary to raise the scows entirely out of the water in order to give sufficient steadiness, so that the transit man could keep his eye to the telescope. The proper outfit of cleats was provided for making fast the ropes which worked these tackles. At each corner of the scow was also fastened securely on deck a cleat to which could be attached an anchor rope. Four small anchors were provided, one at each corner of the scow, by means of which the scow could be brought gradually into position so that the center of the hole would come nearly over any point in the water. If the point was a little above water, as was commonly the case, the scow was brought over the stake by drawing it along in such a manner that the two 4 x 12 small scows would pass each side of the stake, and the stake pass under the deck at the ends of these small scows. The transit scows being in position, and held so by the four anchors, the trestle was placed in position around the stake. Any further adjustment that might be needed was made by means of the anchor ropes. The spuds were let down, sufficient strain put on the tackle, the ropes made fast, and everything was ready for business.

We were also required to make measurements upon the water. For this purpose we used scows, similar to the transit scows, with the spuds left off. These measuring scows, as we called them, would probably have been more useful and could have been brought into position more readily if they, also, had been provided with spuds. We used steel tapes of different lengths up to 500 feet. These tapes were floated on the water by stringing seine floats on the steel tape.

The law requires that every corner of every lot should be marked by a permanent landmark. It also requires that the number of the lot should be marked on at least one of its corners. In carrying out this provision of the law, I used iron pipe to mark the corners of the lots. At first we undertook to use what is known in the market as scrap pipe. This was found to be too poor to stand the driving, so we changed and began using what is known as secondhand pipe. This proved adequate. We used various sizes at first, but finally came to use almost entirely pipe 1¼ to 2 inches in diameter. We used these in pieces from

6 to 16 feet in length; we used a sufficient length so that when the pipe was driven it would stand securely. We provided ourselves with pipe-cutting tools so that we could cut the lengths to suit our requirements. We made a practice of marking the lot numbers on at least two stakes instead of one, as required by law. The marking of these numbers on the stakes was successfully accomplished by using a common prick, or center punch, which could be ground on a common grindstone and tempered as we needed it, by the fire in a coal stove. The figures were made by a series of dots or punch marks. The plan of these figures was worked out in the office, so as to give a uniform system of marking; a punch and a hammer would do the rest with a man to operate them.

We found great difficulty in driving these iron pipes, perhaps the most serious difficulty met with on the survey. We tried various followers for the purpose of driving the pipe below the surface of the water, only to break each one in turn. The pipe had to be driven down to the bottom of the lake in order to prevent their being dangerous to passing boats and vessels. We tried a follower and a sledge, or beetle of some form. We continued increasing the weight and strength of our follower until we made it of steel pipe, costing $1.50 a foot, with a solid steel bottom to it. This we found to be adequate. By this time our follower had become so heavy that we no longer needed the sledge, the weight of the follower being sufficient to do the driving by a churning motion. To this follower we attached a chain, or rather a double chain, with a part running down each side of the follower. We made a simple wooden handle, the central part of which embraced both parts of the chain and the pipe which formed the follower, and by means of wire spikes inserted horizontally in holes through this central part and the links of the chain, the handle could be placed at any elevation required. Two men, one at each end of the handle, by using a churning motion, could settle any stake into position. The bottom end of the follower, made of solid steel, was of a peculiar form. The lower foot of it consisted of a blunt point and a shank, terminating in the upper end in a cup-shaped cavity, turned out of solid steel. This point was inserted in the hole in the pipe, and served as a guide for the motion of the follower when being churned.

The cup shape of the steel at the upper end of the point served to keep the point from brooming up.

Another difficulty was to set the transit over a stake a number of feet under water. To do this we took some very straight pieces of pipe two or three feet long, to be screwed together to make any length required. On the lower end of these we screwed a solid piece of steel, the lower end of which was turned into the form of a spindle, the upper part flaring out to a size larger than the opening in a 2-inch pipe. This plumbing device was inserted in the opening in a pipe, and plumbed by means of a machinist's metal-framed level. This level was applied to two sides of the pipe at right angles with each other, until the pipe was plumb. A blow on top of the pipe, driving it into the stake below, fixed it in position so that it would stand alone. It was then tested for position, and any slight adjustment needed was made. The transit was then set up over this plumbing device as though it were a stake.

These three devices, the iron pipe trestle, the follower for driving the iron pipe stakes, and the plumbing pipe for plumbing up from the bottom of the lake, enable us to set up the transit anywhere, or to drive a stake in any position. In three feet of water the pipe trestle may be made of three-quarter inch pipe with telegraph wire diagonals worked into the rectangles on each side of the trestle. In water deeper than three feet, 1¼ inch pipe should be used.

In order to appreciate the difficulties of this work, one must understand that every mouthful of food, every piece of wood, every stick of lumber, every post, and everything that we needed to use, of however simple a nature, had to be obtained elsewhere, and carried out to the work. The men generally used rubber boots, what are known as thigh boots. We worked summer and winter, and there is not much choice in the seasons. The ice proved very treacherous, and we obliged all men in traveling to take hold of a rope. The man who broke through would know what to do, and the rest of them pulled him out. As far as possible, we prohibited any person from going anywhere alone, as a matter of safety. On much of our work the water was unfit to drink, on account of the drainage from the various club houses, so we obliged the men to drink boiled water. There was

no sickness, although we have had men break through the ice at the rate of half a dozen times a day. As soon as a man broke through, he was rushed off to the quarter-boats, taken into a warm room, heated with a coal stove, stripped, rubbed down, dry clothes put on him, and something given him to eat, if he wished it. And these men invariably returned to the work as soon as they could get there. I do not know of a man who even took cold.

The lots are of every shape and size. There are lots not over 30 feet front, others with perhaps 3,000 feet front; and they are of every shape, even circular. The law provides, in a general way, for a strip of lots 500 feet in depth, fronting on the navigable channels and the open lake, throughout the whole district. These 500-foot strips, following down the bank of the channel to the open lake, the ends joined by a strip of lots 500 feet deep, fronting on the lake, leave large interior areas which were not staked out in lots. The law provides that these great interior areas shall constitute a public park, held in trust by the State for the benefit and enjoyment of the people of the commonwealth. In order to reach this interior park and also in order to give more ready access to the lots that were surveyed, the law provides for strips to be left crossing the 500 strips of land, to be used as public highways.

Besides these highways in general, the law declares that all natural water courses and dredge cuts, and every navigable channel, shall also be a public highway. This raised the question, What is a navigable channel? After some search, it was discovered that courts held the view that a navigable channel was a channel customarily used for the purpose of navigation by craft which were habitually used in the locality where the channel existed. Stated in its simplest terms, this means that any place that would float a duck boat would be considered navigable on the St. Clair Flats, as the duck boat is more generally used for navigation purposes than anything else. It was decided to reserve spaces for highways about 1,000 feet apart. These highways were all surveyed and staked out the same as were the lots, and were mapped and named instead of being numbered.

The surveys are based on the direction of a line joining the upper and lower canal lights of the Lake St. Clair Ship Canal,

the direction and length of this line being furnished by the courtesy of Col. G. J. Lydecker, Engineer Corps, U. S. A. Proceeding from this line, the azimuth was carried by plate readings over the whole work. In order to start the surveys immediately, and to begin laying out lots as soon as possible, a traverse line was carried up stream along the right bank of the South Channel. This traverse line was made the basis of the surveys along that channel. In order to transfer the azimuth to other portions of the Flats, triangles were used to extend the work. They were also used to locate many objects of interest which should appear on our maps. The traverse lines were checked in every way practicable, the measurements verified and the work carefully done in every particular. As the survey advanced, it was possible to form closed polygons. These polygons were computed and the survey verified by comparing the traverses. The field work of surveying the lots was verified in the same manner by dividing up the areas into small closed polygons, figuring these polygons and comparing the traverses. Unless the traverses balanced within what was considered a reasonable difference, the errors in the field work were sought out and corrected. In this way the field work of the whole survey has been verified, errors have been followed diligently, and as we believe, found and corrected. These errors proved to be mainly errors in linear measurement.

In order to make these various computations and comparisons, maps were made continuously as the work progressed. The subdivisions into lots and highways, and the lines for marking the same were largely worked out on these maps, especially where the lots and the lines dividing them were not subject to the wishes of claimants. As fast as the lots were staked out and the work verified, the numbers of the lots were put on at least two stakes, and the stakes marking the corners of lots which came in water were driven down to the bottom of the lake. It was necessary to do this on account of the ice. Had we not done so, it is probable that the position of any stake about which ice formed would have been changed.

The instrumental work was done with instruments reading to minutes and half minutes. All measuring, as stated above, was done with steel tapes of various lengths from 50 to 500 feet, the

length used for any particular work being the one we considered the most convenient for that work. The system of triangles, spoken of above, was extended so as to embrace the entire Flats and a considerable territory besides, to which our operations extended.

The law says that it applies to unsurveyed lands within the delta of the St. Clair River in the township of Clay. Unsurveyed lands are those lying outside or beyond the township, section, and meander lines of the United States Land Survey, and the boundaries of the private claims, of which there are several. From this it will appear that it was necessary to close our surveys on to the older surveys. In order to do so, the lines of the older surveys had to be restored and marked. This of itself was a large work, involving a great deal of labor and taking much time. There are a number of private claims on Harsen's Island, extending from the upper end of the island to some two miles southwest. Our surveys closed upon the lower ends of these claims, which stretch entirely across Harsen's Island from the South Channel to the Middle Channel. The work of restoring these private claims was a serious undertaking. The labor of restoring section and meander lines along the North Channel from the vicinity of Point Tremblé down stream involved the extension of those lines from Anchor Bay and Fair Haven. As there had been a number of surveys relating to these section lines and meander lines, made by different men at different times, and as there was an old Chippewa Reservation involved, besides private claims, and as all traces of the meander lines were gone, the difficulty of fitting these lines back on to the ground in accordance with existing evidences of those surveys perhaps three, four, or five miles away, must be undertaken to be appreciated. There was also a private claim two miles or more in length on Island Stromness. All of these had to be restored, their lines monumented, and their shore boundaries fixed and marked. Our work was then closed upon the restored lines. The different elements of this work were carried on day after day and week after week, as the efficiency of the service seemed to demand. All of them might be going on at once, or one of them alone might receive our attention.

The success of this undertaking, involving so many things

already hinted at, and many more which cannot by any possibility be referred to, is largely due to the ability, attainments, and ceaseless industry of Prof. Fred Morley, who has been in charge of the work.

With these scattering suggestions with regard to the nature, extent, and difficulty of the field work, I will turn to the office work. First comes the statements of the claimants, which, so far as possible, were taken down from the verbal statements of the individual and put in writing, and then submitted to him. Those who could not be reached by a personal interview we endeavored to reach by letter. It may be interesting to state that some of the claimants were found as far away as the State of Washington. It is believed that all or nearly all of them were reached, and their statements obtained. It is highly to the credit of the claimants that they have afforded us every facility to obtain trustworthy information, that they have repeatedly visited us at the Flats for the purpose of giving us information, in some instances coming considerable distances. The statements of these claimants were copied into a book specially set apart for that purpose, and then compared with the original record. These books are called "Claim Books." The different sections of the survey were classified according to their location. As an example, the South Channel section, the Middle Channel section, the Snibora Channel section, the Anchor Bay section, etc. Besides these Claim Books, there has been accumulated a large amount of correspondence and written information relating to these claims and the lands on the Flats. As far as possible, and I think almost without exception, every claim has been given a separate lot number. This number becomes the index to all material relating to that claim. Some extra large filing envelopes were prepared, and all papers and documents relating to each claim have been filed in them. All field note books of the transit work, the measurements, the traverse, the triangulation, and all special surveys of every nature were compared and prepared in the form of a permanent record. All the computations have also been copied in ink, and prepared in permanent form. These things alone make a number of sets of books.

Besides these books are the maps. Before beginning any maps it was necessary to decide on a standard size of sheet, and

from that a standard scale to be used in plotting all of this work. The size of sheet adopted was 16 x 26 inches. This size, when folded twice, reduced to the size, 8 x 13 inches, of an ordinary legal document. The scale adopted was 80 feet to the inch. This was done in order that a common carpenter's rule could be used for making measurements, 1/8 inch being 10 feet. It was further necessary to plan the maps with the view of their permanent preservation, and to preclude the possibility of any of them being lost. To accomplish this there is first the original map, made on Whatman drawing paper. From this is prepared a cloth tracing. The original map, on drawing paper, is to be filed in the vaults of the State Land Office at Lansing. For the office use reference is had to the tracings. For the use of the public, blue prints are made from these tracings. It is quite possible that an official might serve a number of terms in the State Land Office, without ever coming in contact with the original maps; the only conceivable occasion for referring to the original maps would be, should the tracings through continued use ever become worn out.

Besides these precautions, it became necessary to provide, in addition to the ordinary title, a statement which should appear on every sheet, that would identify that sheet as a part of the map of the St. Clair Flats Survey without the necessity of referring to any other document. Such a statement was prepared, and appears on every sheet or blue print, and it is believed, identifies each blue print as a constituent part of the maps of this survey.

After the original maps were made and tracings of them carefully verified, one with another, and also with the original field note books, we made for ourselves, and for various business uses, six copies of blue prints. As there are some 250 or more sheets on the survey, it may be observed that this involved the preparation of 1,500 blue prints. Besides these maps, special sheets, where they seemed necessary, were made. In addition to these there is now being prepared on a scale of 800 feet to the inch, a general map of the whole work. There is shown on these sheets, and there will be shown quite generally on the large map also, every important building, every channel, every dredge cut, every dock, every dredge dump, every piece of grading or raised ground, and every material thing that will assist in determining the position of the corners of the lots. This involved

the taking of a large amount of topography, all the field notes of which were copied, compared, and verified, and constitute a part of the returns. As a further proof of the correctness of the work, the large general map, spoken of above, is being constructed from the data contained on the blue prints.

The returns will consist of the original sheets and the tracings from them, the large general map, copies of all field note books, the computation books, the claim books, all papers relating to every claim that has come into our possession, and a complete card index of the entire collection. It is also contemplated that the office shall prepare a book index arranged in alphabetical order. This is for the purpose of enabling the information to be quickly reached whether the number of the lot or claim is known, or whether some statement connected with the owner's name is furnished.

The force employed consisted of twenty-five men or less, according to the requirements of the work. The organization consisted of the resident engineer, mentioned above, who had entire charge of the work. Associated with him, and as a representative from the State Land Office at Lansing, was the gentleman who took charge of the entire financial end of the work. It was his business to provide quarters and supplies of all kinds. He was custodian of the property, and made all purchases and rendered all bills and accounts to the office. Next to these gentlemen came the instrument men — two or three or more, as circumstances required,— and the draughtsman in the office. Then came the chainmen and copyists, and after these the assistants, helpers, and laborers. There was also employed a man known as a mechanic. This man was employed on account of his special fitness and ability to make or to do anything that was needed. There was also kept a cook and one or more assistants whose business it was to prepare the meals, keep the quarters in order, and perform such other services as they might be called upon to perform. A form of enlistment was prepared, and every man who entered the service was required to sign an enlistment paper, and assume an obligation, which, in consideration of his pay, gave us his entire time. The use of liquor was absolutely prohibited, and, as we believe, with great profit.

The attempt has been to make the survey trustworthy in every

respect. Beyond this we have not attempted to go. In the map making, the object has been to show every detail, including every shore line, every island of rushes, and to make this information appear, plain and distinct, on every sheet. There has been no attempt at fancy work in the office. The object has been solely plainness and neatness.

To give some idea of the magnitude of the work, it may be said that we commenced buying iron pipe by the ton and ended by buying it by the carload.

During winters, when the weather prevented field work, duties were found for every man, as far as practicable, in repairing and improving the apparatus, and in keeping the outfit in order; a large amount of copying was done by men who worked in the field. By the exercise of ordinary prudent foresight, it has been possible to carry on the work steadily and continuously, and also efficiently without hindrance on account of breakages or breakdowns of any kind whatever. One of the most troublesome things was the breakage of steel tapes. Our mechanic soon learned to repair these so quickly that I have known a broken steel tape to be brought in at night, and before we sat down to supper it would be repaired and ready to use the next morning.

Should the details above given prove of any service to others undertaking a similar work, the object of their preservation here will have been accomplished.

THE "MANUAL OF 1902," OF INSTRUCTIONS TO UNITED STATES SURVEYORS.

A. W. BARBER.

THE forthcoming edition of the "Manual of Instructions for the Survey of Public Lands of the United States," will be designated briefly as the "Manual of 1902." The manuscript was officially approved by the Department on Dec. 30, 1901, and the book is now about to be printed.

In most respects the forms and methods of the "Manual of 1894" are adhered to, with as few changes as possible. The treatment of the subject has been conservative, except where it seemed necessary to shut still more closely the doors of fraud, negligence, or incompetency. Efforts are made to systematize the instructions, to condense and simplify rules, and to avoid repetition. Footnotes and cross references have mostly been stricken out, and their place is supplied by an exhaustive index.

The whole work is divided into four hundred sections, consecutively numbered, instead of the former irregular method. It is designed to adapt this work to the perfected modern instruments and requirements, and to discard those of early days, while retaining the excellent fundamental principles of statutes made in the days of our grandfathers. No encouragement is shown to those who would remove the ancient landmarks.

Here are the more salient of the new features of this edition: —

The United States statute of June 10, 1896, fixing penalties for removing or destroying a government corner, is inserted among the laws.

The importance of taking all courses from the sun or the pole-star, and of avoiding dependence on the needle, is more stringently set forth.

The certainty that contract surveys will not be accepted till they have been inspected by a qualified examiner, selected after civil service examination, by the Commissioner and the Department, is alluded to in various sections, as full warning to all deputies who are inclined to pursue the cheap and slipshod methods of old times.

Steel tapes reading by chains and links are approved as chains, and engineers' measure by feet is prohibited.

The ancient rules for blazing and marking lines in timber are more clearly inculcated, and the use of wooden posts strongly condemned wherever stones can possibly be used.

Perishable accessories to corners, such as bearing trees, and mounds of earth, are discouraged, and bearing rocks and mounds of stones are recommended instead.

In descriptions of corners, all marked letters and figures (for instance, T 4 N R 3 W S 1 B T) are printed with no punctuation marks, just as the surveyor is expected to mark them in actual practice.

Deputies are not allowed to meander such lines as margins of impassable cañons or swamps, or between the foot of a mountain side and the agricultural land of the valley.

Meandering is defined as applicable only to the shore or margin of a stream. Several court decisions are cited, or quoted from, as to the effect of meander lines and the extent of riparian rights.

Surveyors general are not allowed to employ the office force upon the correction or revision of material portions of field notes, to place them in condition for filing, and thus aid incompetent deputies. They are also prohibited from receiving and filing the returns, until they are completed by affixing the necessary oaths.

A practice often introduced by draftsmen, of inserting little circles at angles of lines on their plats, and making other alleged ornaments, which are merely blemishes, is also interdicted.

The positions of all base lines and principal meridians are shown by a new and compendious table.

Magnetic needle surveys are unreservedly condemned. In accord with this rule, the new edition omits all the large amount of data which was given in former editions, on the history of magnetic declination in all parts of the country, and its rate of annual change. Deputies are not required to state the variation at which their lines are run, or to pay but the slightest incidental regard to that unreliable and useless quantity.

Any surveyor fit to be entrusted with public employment should be able to observe Polaris, lay a true meridian, adjust and use a solar transit, and execute a survey with courses that a good examiner can retrace and verify to within two or three minutes of arc, with no magnetic needle in possession of either of them to

confuse and lead them astray. Whenever a deputy undertakes to make an extensive survey, using only courses read at the point of his needle, he is making a strong bid for the rejection of his work. Still a few ignorant deputies persist in trying it, and the list of rejections even in 1901 shows the results of their experiments.

The table showing times of upper culmination of Polaris has been calculated for years from 1901 to 1911, inclusive.

The table for both elongations and both culminations has been omitted, and rules are given by which to deduce such data from upper culmination.

The table of azimuths of Polaris for hour-angle observations has been calculated for ten years in advance.

A set of examples is given and worked, to aid the beginner in the use of the various tables and rules.

The table of convergency of meridians, formerly covering latitudes thirty degrees to fifty degrees, is now extended to latitude seventy degrees, and is applicable to Alaska, even beyond Bering Strait.

In triangulation over impassable objects, it is desired that the base shall be at least as long as the required distance; and in case of difficulty the angle opposite the base should not be less than fifteen degrees.

The practice of obtaining true meridian by a single solar observation with plain transit, is viewed with disfavor, as it is believed to be unreliable and prolific of error in hasty or unskillful hands, hence an unsafe substitute for the simple and certain processes by Polaris. Deputies and examiners, therefore, are not warranted in abandoning the means heretofore enjoined and using the process of long and intricate calculation in the most valuable hours of the day.

Rules are given for setting a watch to correct local mean time, involving equation of time and standard time, in connection with noon observations for latitude.

The duties of field inspectors are briefly detailed, and great certainty and precision required in their reports, that exact justice be done to the work being examined.

The specimen field notes are abridged by omitting a large amount which seemed mere useless repetition of routine matter. A material diminution in the size of the book is hoped for as the result.

Dec. 31, 1901.

RECENT LEGAL DECISIONS FROM ADVANCE SHEETS OF AMERICAN DIGEST.

ADVERSE POSSESSION.

1. A claim of adverse possession cannot be maintained against a municipality.— Mobile Transp. Co. v. City of Mobile (Ala. 1900), 30 So. 645.

2. An alley dedicated for the common use of two abutting lots had been adversely used by the owner of one of the lots for more than 40 years, when the city brought an action to have the way declared an alley, and to cause obstructions to be removed. *Held,* that by such continuous adverse possession the right of the city and the other owner was barred by the statute of limitations.— Hegan v. Pendennis Club (Ky. 1901), 64 S. W. 464, 23 Ky. Law Rep. 861.

3. Occupancy of a public street under lease from the municipality is not rendered adverse by the fact that the municipality had no power to authorize the obstruction of the street.— W. N. Eisendrath & Co. v. City of Chicago (Ill. 1901), 61 N. E. 419, 192 Ill. 320.

4. Where defendant erected a fence on what he thought to be the boundary line of his lot, but which in fact included some of the plaintiff's land, and maintained the same for the statutory period, regarding it as the true boundary, but not claiming plaintiff's land so included, except as part of the lot, the possession was not adverse, so as to ripen into title by limitation. — Palmer v. Osborne (Iowa 1901), 87 N. W. 712.

BOUNDARIES.

1. Where plaintiff owns the east half of a quarter section, and the defendants own the west half, the division line between their lands is equidistant from the east and west boundary lines of the quarter section, though such quarter section be fractional by reason of the north boundary line thereof being the meander line of a stream or lake, so that there is more land in the east half than there is in the west half.— Edinger v. Woodke (Mich. 1901), 86 N. W. 397, 8 Detroit Leg. N. 233.

2. Rev. St. U S. Section 2396 declares that in determining

the contents of subdivisions of the government lands, the corners of half and quarter sections, not marked on the surveys, shall be placed as nearly as possible equidistant from two corners which stand on the same line, and that, in portions of fractional townships where no opposite corresponding corners have been fixed, the boundary lines shall be ascertained by running from the established corners due north and south, or east and west, to the water course, Indian boundary line, or other external boundary of such fractional townships. *Held*, that where the owners of the N. E. ¼ of the S. E. ¼ of a section contended that the owners of the S. E. ¼ of such quarter section had cut timber over the boundary line, and the S. E. ¼ of the section was fractional, owing to a lake being partly in the N. E. ¼ of the quarter section, there being no east quarter post, as it appeared by the government map that it would fall in the lake, and it was shown that the east quarter post, as established by placing it equidistant between the northeast and southeast corners of the section, or as determined by running a mesne line from the west quarter post, would give the north line of the S. E. ¼ of the S. E. ¼, as established by a mesne line between the south line of the section and the east and west quarter line, such a location as to show defendants had trespassed, a judgment in favor of plaintiffs was proper.— Underwood v. Smith (Wis. 1901), 85 N. W. 384.

3. The question of boundary between two quarter sections, the original monuments at the quarter-section corners between the two sections having been long destroyed, is for the jury; plaintiff, to establish these corners according to his contention, having introduced the evidence of surveyors, who claimed to have established the points at which the government mounds formerly stood by surveys made in accordance with the original government field notes showing the courses and distances, in connection with the existing monuments, and defendant having introduced the testimony of witnesses who gave from recollection the points where the mounds stood.— White v. Amrhien (S. D. 1901), 85 N. W. 191.

4. A survey of plaintiff's land called for the well-established corner of another survey, and did not indicate that the north line extended beyond that corner. At the time of the survey

it was accepted that that corner marked the western boundary of another survey adjacent to plaintiff on the east, which the owner occupied, but it was later discovered that the true boundary of such survey was a considerable distance further east. The line from the corner to plaintiff's south line marking his eastern boundary was well established by the marks and calls for distances, but the survey called for the western boundary of the adjacent survey. *Held,* that plaintiff's eastern boundary did not extend to the western boundary of such survey.— Morgan v. Mowles (Tex. Civ. App. 1901), 61 S. W. 155.

5. The rule that, where a deed calls for the meanders of a stream as a line, the line extends to the thread of the stream, does not apply where the grantor has by deed of record previously conveyed the bed of the stream to another.— Penrod v. Bruce (Ky. 1901), 61 S. W. 1.

6. In trespass involving a disputed boundary line between adjoining owners, proof that the line established by the parties by parol varied from the government section line did not constitute a variance, since it was competent for the parties to establish a binding division line contrary to the government section line by parol.— La Mont v. Dickinson (Ill. 1901), 60, N. E. 40, 189 Ill. 628.

7. The location of a quarter-section boundary line was in issue in an action of ejectment, and the plaintiff contended that one quarter post had been lost, and that the quarter line should be run equidistant between the two section corners. He produced three surveyors who had made surveys of the section, but they all differed as to the exact location of the line; but, if either was correct, defendant's fence was on plaintiff's land. Defendant claimed that the fence was built in accordance with the line pointed out by plaintiff, and with other fences in the neighborhood; but plaintiff denied that the fence was intended to be permanent, as no one knew the location of the line at the time it was built. *Held,* that it was error to direct a verdict for the defendant since the question whether the fence was built by agreement, or whether either party was estopped by his conduct or long acquiescence, and which was the correct line, were questions for the jury.— Schlei v. Struck (Wis. 1901), 85 N. W. 430.

8. Where a fenced and laid-out public street is mentioned as the boundary of land, it means the street as actually laid out and fenced, and not as it appears on a map filed by public officers, showing an intention on their part to change its width. Order (1900) 62 N. Y. S. 347, 47 App. Div. 42, affirmed.— Singer v. City of New York (N. Y. 1901), 59 N. E. 1130.

9. In an action of ejectment for a strip of land 1 foot 3 inches wide, where the starting point of the description is conceded, but there are no monuments referred to in plaintiff's deed, nor any call for adjoining lots or division fences, and the lot is described by a particular number, but there is no proper plan of lots attached to the deed, and no reference to such a plan as having been recorded, the plaintiff is confined to the courses and distances mentioned in the deed.— Green v. Schrack (Pa. Super. Ct. 1901), 16 Pa. Super. Ct. 26.

10. Defendant built a fence on what he believed to be the boundary between his lot and that of plaintiff, but in fact on plaintiff's land, and including part of his lot. The lot was unoccupied, and plaintiff was a nonresident, and had no notice of the existence of the fence, except that which might be implied from ownership. *Held*, that there was no acquiescence in the boundary, as established by the fence, from which an agreement that it was the true boundary might be presumed.— Palmer v. Osborne (Iowa 1901), 87 N. W. 712.

11. A parol agreement between adjoining owners fixing the dividing line between their lands is valid when executed, and will be upheld.— Campbell v. Campbell (Ky. 1901), 64 S. W. 458, 23 Ky. Law Rep. 869.

12. Where plaintiffs were adjoining landowners to defendant, and had agreed with him as to the true division line between them, and had permitted him to build up to the line so agreed upon, they were estopped, in the absence of fraud, from subsequently denying that the line agreed on was the true line. Judgment (1900) 66 N. Y. S. 137, 32 Misc. Rep. 17, affirmed.— Blumenauer v. O'Connor (N. Y. Sup. 1901), 71 N. Y. S. 1133.

13. A patent by the United States to land along a stream where the tide ebbs and flows conveys to the high-tide line along the shore.— Mobile Transp. Co. v. City of Mobile (Ala. 1900), 30 So. 645.

14. The lines of a government township are determined by the monuments in the field.— Harrington v. Boehmer (Cal. 1901), 66 P. 214, 489.

15. A government township lies where the government surveyor lines it out on the face of the earth.— Harrington v. Boehmer (Cal. 1901), 66 P. 214, 489.

16. Where there is a discrepancy between field notes and a plat, the latter must give way to the former.— Harrington v. Boehmer (Cal. 1901), 66 P. 214, 489.

17. Ordinary high-water mark of a river is a line which is shown by the character and condition of the soil and vegetation to be the limit to which high water ordinarily reaches, such vegetation not including those trees which grow and flourish best in the immediate vicinity of running streams, and which can withstand the effect of water encompassing the lower part of their trunks without injury, and for a longer period than other kinds of trees.— Welch v. Browning (Iowa 1901), 87 N. W. 430.

18. There is a strong and well-recognized presumption of law that a grantor who conveys property abutting on a public highway does not intend to reserve to himself the fee of the bed of such highway; clear and decisive language showing a contrary intention being required to rebut such presumption.— Pell v. Pell (N. Y. Sup. 1901), 71 N. Y. S. 1092, 35 Misc. Rep. 472.

19. Where the field notes show that a survey commenced at a later date than others was surveyed as No. 44, and the others of prior dates, as Nos. 45 and 53, respectively, the former being the first completed, its boundaries are entitled to precedence over the others.— Albert v. City of Salem (Or. 1901), 65 P. 1068.

20. In an action of trespass, where the fact that the parties had agreed on a dividing line by deed is clearly established, no evidence of the true line as claimed by one of the parties is admissible.— Perry v. Jefferies (S. C. 1901), 39 S. E. 515, 61 S. C. 292.

21. Where a conveyance of realty calls for a swamp, and thence along the swamp, grantee's title extends only to the banks of the swamp, and not to the run of the swamp, since

the rule that a call in a deed for the banks of a stream takes the title to the middle of the stream, does not obtain where the call is for a swamp.— Rowe v. Cape Fear Lumber Co. (N. C. 1901), 38 S. E. 896.

22. Where the true dividing line between adjacent landowners is unknown, and they agree on a fixed line as the true line, and thereafter the parties ignore it, in an action between them to determine the line, the true line according to the survey will be enforced.—Brummell v. Harris (Mo. 1901), 63 S. W. 497.

DEDICATION.

1. A dedication of land for a highway of a specified width is accepted, so as to be binding on the persons dedicating the same, where the council of the municipality consents to its being laid out to the width specified, and causes it to be graded as a street, and expends public money for such work.— Pedlow v. Renfrew (Can. 1900), 27 Ont. App. 611.

2. A dedication of 20 feet of land for a highway is binding on the one making it, although it was agreed between him and his adjoining neighbor that each should dedicate 20 feet, and the latter dedicated 40 feet from his land.— Pedlow v. Renfrew (Can. 1900), 27 Ont. App. 611.

3. A dedication of land for a highway takes place where adjoining owners agree that each shall dedicate a specified width of land, the fences are moved back to that distance, and a plan is prepared and signed by them showing the street so formed. — Pedlow v. Renfrew (Can. 1900), 27 Ont. App. 611.

4. A street with a river as one boundary, extends to the center of the river.— Davenport & R. I. Bridge Ry. & Terminal Co. v. Johnson (Ill. 1900), 59 N. E. 497; Same v. Hass, Id.

5. A dedication of land for a public highway may be either express — as where the owner manifests his purpose by a grant evidenced by writing — or implied when the acts and conduct of the owner clearly manifest the intention on his part to devote the land to the public use; but in either case it is always a question of intention, and no particular formality or form of words is necessary.— Schettler v. Lynch (Utah 1901), 64 P. 955.

6. References in a deed to a plan have the effect of making the plan a part of the deed, and constitute a dedication

of the streets and alleys laid down on the plan to the use of the purchasers as public ways.— Witman v. Smeltzer (Pa. Super. Ct. 1901), 16 Pa. Super. Ct. 285.

7. Where the dedication of a city street is on condition that the city forthwith make certain expenditure thereon, and the city fails so to do, the dedication is invalid.— Gregory v. City of Ann Arbor (Mich. 1901), 86 N. W. 1013, 8 Detroit Leg. N. 412.

8. Under a city charter requiring all resolutions of the council to be adopted by a vote of the majority thereof, a resolution accepting the dedication of a street, which receives the affirmative votes of less than a majority of the council, does not constitute a valid acceptance thereof.— Gregory v. City of Ann Arbor (Mich. 1901), 86 N. W. 1013, 8 Detroit Leg. N. 412.

9. A plat dedicating a city street 42 feet wide was filed, but was withdrawn before its acceptance; but a resolution declaring a street 45 feet wide to be a necessity was afterward passed by the council. *Held*, that the city acquired no rights by the filing of the plat.— Gregory v. City of Ann Arbor (Mich. 1901), 86 N. W. 1013, 8 Detroit Leg. N. 412.

10. A deed dedicating a city street, which is not joined in by a mortgagee of the land, confers no right on the city as against the mortgagee.— Gregory v. City of Ann Arbor (Mich. 1901), 86 N. W. 1013, 8 Detroit Leg. N. 412.

DEEDS.

1. A river ran through a quarter section of school land at the time of the government survey so as to leave 83.2 acres of land, part being north and part south of the river. The river was meandered, but the section was not subdivided by the government. The State issued a patent to plaintiff for 40 acres of the east end of the quarter section, and a patent to another for 43.2 acres of the quarter. *Held*, that plaintiff's patent vested title in her to 40 acres on the east side of the quarter section, excluding the river as meandered by the United States survey; that the width of such tract was equal on the north and south lines thereof, and the west line thereof parallel with the east line of the section.— Dashiel v. Harshman (Iowa 1901), 85 N. W. 85.

2. Where in a deed of land there are no express averments

or covenants as to quantity, a statement as to the number of acres conveyed will yield to the actual area, as ascertained by reference to the plat, field notes, monuments, or other certain descriptions of the premises conveyed.— Dashiel v. Harshman (Iowa 1901), 85 N. W. 85.

3. Where the description in a deed calls for the beginning to commence at a well on the north side of a road and concludes with a call to the place of beginning, and the description, when applied to the premises, will not end at the place of beginning, and the probabilities of error in the last call are greater than a supposed error in another call, the manifest error in the description may be corrected by extending the last call far enough, so that, following the remaining courses and distances, the last call will end at the well.— Richardson v. Watts (Me. 1901), 48 A. 180, 94 Me. 476.

4. Where the owner of land sold and conveyed by proper description the east half and the northwest quarter of the tract, and afterward sold the southwest quarter to another person, but in his deed described it as an undivided fourth of the entire tract, the conveyances show that he had parted with his entire interest in the land, and a quitclaim deed of the tract from his heirs conveyed no title or interest.— McVey v. Carr (Mo. 1901), 60 S. W. 1034.

5. In construing a deed, no inaccuracy of language will be allowed to defeat the manifest intent; and every clause, and even every word, should, when possible, have assigned to it some meaning.— Jacoby v. Nichols (Ky. 1901), 62 S. W. 734.

6. A description of land, in an instrument conveying an interest therein, as the " N. E. ¼ " of a specified section, sufficiently identifies the land conveyed as the northeast quarter of such section.— Abell v. McLaren (Can. 1901), 13 Man. R. 463.

7. A deed described the land conveyed as bounded on the north by the lands of W. and N. *Held,* not to include a strip intermediate the lands of W. and N., bounded on the west by W.'s land and on the east by that of N.— Gogle v. Dreger (Mich. 1901), 87 N. W. 78, 8 Detroit Leg. N. 516.

8. A deed with the notary taking the grantor's acknowledgment as the only witness, is effective to convey the land.— Carpenter v. Carpenter (Mich. 1901), 85 N. W. 576.

9. Where, in a deed, the land is fully and correctly described, except the number of the township is given as "45" instead of "4," and the land can be identified by the rest of the description, such mistake will not vitiate the conveyance.— Borchard v. Eastwood (Cal. 1901), 65 P. 1047.

10. An accretion of sufficient elevation above the water to be susceptible of private ownership passes with a conveyance of the land, unless expressly reserved in the deed. Judgment (1900), 59 S. W. 1096, reversed on rehearing.— Towell v. Etter (Ark. 1901), 63 S. W. 53.

11. Where a deed describes the lot conveyed by metes and bounds, and then attempts to further describe it by giving a map number which conflicts with the previous description, the lot must be located according to the particular description, and not the map number given.— Hale v. Swift (Ky. 1901), 63 S. W. 288.

12. There being no ambiguity, the court will not consider the conditions of the parties, and their objects and needs, to arrive at the meaning of the language used.— Fisher v. Hall's Ex'r (Ky. 1901), 63 S. W. 287.

13. A conveyance is to be governed by the law in force at the time of its execution.— Frame v. Humphreys (Mo. 1901), 64 S. W. 116.

DRAINS.

1. Where a drain is constructed by mutual agreement of two adjoining landowners, and by mistake as to the location of the line it is constructed wholly on the land of one of them, such owner, after utilizing the drain, will not be sustained in obstructing it because of its mistaken location.— Hall v. Pfnister (Ill. App. 1901), 95 Ill. App. 159.

2 Under Pub. Acts 1899 No. 272, amending prior drainage laws, providing that all acts or parts of acts were thereby repealed, saving all acts done and all rights acquired at the time such acts took effect, and any proceedings had or begun might be carried forward and completed thereunder the same as they might have been done had such act not been passed, proceedings commenced under such former acts must be completed thereunder.— Gitchel v. Whipple (Mich. 1901), 86 N. W. 144, 8 Detroit Leg. N. 187.

3. The fact that the minutes of the survey accompanying the application for the establishment of a drain are not signed by the surveyor, does not invalidate the proceedings, the statute only requiring a certified copy of such written minutes.— Hackett v. Brown (Mich. 1901), 87 N. W. 102, 8 Detroit Leg. N. 559.

4. Where plaintiff acquired title to land after proceedings begun for the establishment of a drain across the entire tract, and the survey had been made, which showed the length of the drain on the land at the time when made, as required by the statute, the plaintiff cannot raise the objection that the application does not show the length of the drain on plaintiff's land. — Hackett v. Brown (Mich. 1901), 87 N. W. 102, 8 Detroit Leg. N. 559.

5. Where plaintiff claimed the title to certain land through a contract of sale executed after proceedings for the construction of a drain across it had been instituted, and which contract had been dated back, and was not recorded until the meeting of the second set of special drainage commissioners, and the plaintiff, though residing in the county, never took possession of the land, the contract of sale will not be deemed bona fide, being made to permit plaintiff to raise objections to the proceedings which the original owner had lost the right to make.— Hackett v. Brown (Mich. 1901), 87 N. W. 102, 8 Detroit Leg. N. 559.

6. Where the drain commissioner in his return denied that the proposed drain would divert the flow of water from where it had been accustomed to run for 20 years, the statement will be taken as true.— Hackett v. Brown (Mich. 1901), 87 N. W. 102, 8 Detroit Leg. N. 559.

7. Where plaintiff was present at the meeting of the second set of special drainage commissioners, appointed in proceedings for the establishment of a drain, and, knowing that the drain was being constructed through the land in question, never served any notice on the drain commissioner that he owned the land, and the question of a notice to plaintiff was not raised in the lower court, he has no standing in the supreme court to object for lack of notice.— Hackett v. Brown (Mich. 1901), 87 N. W. 102, 8 Detroit Leg. N. 559.

LANDS UNDER OR BORDERING ON WATERS.

1. A bay or arm of one of the Great Lakes, some 4,000 acres in extent, which was patented to the State as swamp land, and which, though of sufficient depth for navigation where it opens into the lake, is not throughout the remainder of its extent of an average depth of more than two feet, and rarely more than three feet, and is covered through the summer with grass and rushes, is not navigable water, but merely a marsh, and subject to private ownership.— Baldwin v. Erie Shooting Club (Mich. 1901), 87 N. W. 59, 8 Detroit Leg. N. 535.

2. It is not necessary that a particular locality should be wholly covered by water constantly, or to be covered sufficiently to be susceptible of navigation, to give thereto the character of a lake bed as regards title thereto; for, if a body of water is not a river, yet is reasonably constant in character, it is a pond or lake, and the limits thereof are the natural shore, though water does not constantly stand at that point.— Illinois Steel Co. v. Bilot (Wis. 1901), 85 N. W. 402, denying rehearing 84 N. W. 855.

3. The title to the shore and soil under navigable rivers below ordinary high-water mark is vested in the State within whose territory it lies, where there had been no valid grant of the same prior to its admission into the Union. Such title, however, does not give an absolute ownership, but is held for the conservation and protection of the rights of the public in the use of the waters of the stream, and subject to the rights of riparian owners.— Leverich v. City of Mobile (U. S. C. C., Ala. 1867), 110 F. 170.

4. The State may grant the fee of its shores of tide water to a municipality in furtherance of the public interests, subject to the rights of the United States, respecting navigation.— Mobile Transp. Co. v. City of Mobile (Ala. 1900), 30 So. 645.

5. In ejectment by a municipality to recover the shore below high-water mark granted the city by the State, a charge limiting plaintiff's right to recover the lands covered by the description in the complaint on the ground that the description takes the line far inland, is properly refused, where the complaint describes the shore line as extending along the high-

water mark.— Mobile Transp. Co. v. City of Mobile (Ala. 1900), 30 So. 645.

6. Such charge was properly refused as limiting the recovery to the present high-tide line, which might be different from what it was when the grant was made or the suit commenced.— Mobile Transp. Co. v. City of Mobile (Ala. 1900), 30 So. 645.

7. Where an island arose in a navigable river, apart from riparian owners' land, such owners can claim no title thereto by reason of their riparian rights, though the island was afterward joined to their land, since it did not become part thereof by gradual accretion to or reliction from the shore.— Holman v. Hodges (Iowa 1901), 84 N. W. 950.

8. Where an island sprung up from the bed of a navigable river, and was afterward joined to the mainland, the State's title thereto, as owner of the river bottom, did not recede from the land with the water, as that occurs only in case of gradual accretion or reliction, but continued in the State.— Holman v. Hodges (Iowa 1901), 84 N. W. 950.

9. Plaintiff was the owner of a 40-acre tract of land, which at the time of the government survey in 1855, and presumably when the patent was issued, was separated from the Missouri River on the west by two fractional 40-acre tracts belonging to defendant. By the erosion of the water a part of defendant's land was washed away until the river reached the plaintiff's said tract, and, by eating away a part of it, left the latter a shore line of about 700 feet. The river then receded, forming alluvion from the line of contact with plaintiff's land westward within the original surveyed lines of the defendant, and past the same to the river. This alluvion also attached itself to what was left of defendant's land. *Held,* that plaintiff was not only entitled to such alluvion as formed within his original lines, but also to an equitable proportion of that formed within the original surveyed lines of defendant's land, and beyond to the river bank.— Peuker v. Canter (Kan. 1901), 63 P. 617.

10. Meandered lines along the shore of a navigable river represent the border line of the stream, and show that the water course, and not the meander line as actually run on the land, is the boundary.— Peuker v. Canter (Kan. 1901), 63 P. 617.

11. The bank of a river between high- and low-water mark belongs to the owner of the land above high-water mark.— Meek v. Catlettsburg & P. Packet Co. (Ky. 1901), 60 S. W. 484.

12. Land which at the time of the federal swamp land act of 1850 (Rev. St. U. S. Section 2479), granting swamp land to the States, was connected with an island in a navigable lake, but was so low that it was ordinarily but a few inches above the water, and in times of high water, wholly submerged, was not a part of the bed of the lake, but was swamp land within the act so as not to pass to the State thereby.— State v. Lake St. Clair Fishing & Shooting Club (Mich. 1901), 87 N. W. 117, 8 Detroit Leg. N. 373.

13. Rev. St. U. S. Section 2479 (federal swamp land act of 1850), granting swamp lands to States conveyed title to the State at the time of the grant, and the State was entitled to maintain ejectment thereon after it had been determined by approved survey what subdivisions of land were included in the grant.— State v. Lake St. Clair Fishing & Shooting Club (Mich. 1901), 87 N. W. 117, 8 Detroit Leg. N. 373.

14. Under a joint resolution of the Legislature authorizing a contractor to select a certain number of acres from any State swamp lands not otherwise appropriated, the selection is not limited to lands subject to entry, but may be made from lands which have not been patent to the State by the United States, but which have been selected, so that the title has vested in the State, and the lands have been identified.— Olds v. Commissioner of State Land Office (Mich. 1901), 86 N. W. 956, 8 Detroit Leg. N. 383.

15. Where swampy land adjacent to Lake Erie was surveyed by the federal government, bounded by the meander line of the lake, such survey is conclusive that the land is not a part of the bed of the lake; hence one who has derived title thereto from the State, to which the land was conveyed under the State swamp land act, has full title thereto, and may prohibit the hunting of ducks thereon.— Brown v. Parker (Mich. 1901), 86 N. W. 989, 8 Detroit Leg. N. 386.

16. Where a meandered navigable stream runs through a government subdivision of land, a patent of such subdivision does not convey to the patentee title to the land in the stream

between the meander lines, since title to such lands is in the State, subject only to the riparian rights of the owner of the land on either bank, and, the lines being subject to change, the title of the adjoining owner follows the meanderings of the stream. — Dashiel v. Harshman (Iowa 1901), 85 N. W. 85.

17. The presumption as regards land covered by water of lakes in the territory out of which Wisconsin was formed is that the trust in the United States in behalf of the public attached thereto before the government survey was made, and that the extension of such survey over and the conveyance of such land in form was void.— Illinois Steel Co. v. Bilot (Wis. 1901), 84 N. W. 855.

18. Land covered by the waters of lakes or ponds, or by water partaking of like character as regards public rights, though in form conveyed by a federal or State patent, is vested in the State the same after such conveyance as before, such conveyance, as to such land, being absolutely void.— Illinois Steel Co. v. Bilot (Wis. 1901), 84 N. W. 855.

19. The title to land covered by waters of lakes or ponds, in the territory out of which the State of Wisconsin was formed, prior to such formation, was in the United States in trust to preserve to the people of prospective States the enjoyment of the waters covering the same to the line of ordinary high-water mark, and passed to the State when it was admitted into the Union.— Illinois Steel Co. v. Bilot (Wis. 1901), 84 N. W. 855.

21. The title to land held by the State in trust to preserve to the people thereof the enjoyment of lakes and ponds does not change by artificial filling so as to raise the surface above the level of the water.— Illinois Steel Co. v. Bilot (Wis. 1901), 84 N. W. 855.

21. The mere ownership of the shore, where title stops at the water's edge by reason of the public character of such water, does not entitle one to maintain ejectment to obtain possession of land beyond the water's edge.— Illinois Steel Co. v. Bilot (Wis. 1901), 84 N. W. 855.

22. Private interests in land, if there be any below the line of ordinary high-water mark of public waters, are *prima facie* incident to the ownership of the shore, and if title to the latter be devested from one by adverse possession, the interests which

are incidental thereto pass with it.— Illinois Steel Co. v. Bilot (Wis. 1901), 84 N. W. 855.

23. In determining the extent of the boundaries of a riparian owner, his boundary line should be so projected from the shore as to give the adjoining proprietor a portion of the accretions to the center thread of the stream in proportion to his shore line. — Nauman v. Burch (Ill. App. 1900), 91 Ill. App. 48.

24. The title of a riparian owner as proprietor extends to the middle thread of the stream on which he abuts.— Nauman v. Burch, (Ill. App. 1900), 91 Ill. App. 48.

25. The possession of a land proprietor abutting on a river extends to the middle of the stream to as full an extent as if expressly included in the terms of the deed under which he claims.— Nauman v. Burch (Ill. App. 1900), 91 Ill. App. 48.

MONUMENTS.

1. Where the alleged monuments in the description of a highway contained in the order laying out the highway could not be located by the order, but only by resort to the original survey, they were not monuments, within the meaning of the rule that, in case of ambiguity, courses and distances must yield to monuments, and therefore they could not be used to cure alleged ambiguities in the order.— Blair v. Milwaukee Light, Heat & Traction Co. (Wis. 1901), 85 N. W. 675.

FRACTIONAL LOTS EXTENDING BEYOND A SECTION LINE. OPINION OF THE COMMISSIONER OF THE GENERAL LAND OFFICE, FEB. 4, 1902.

Mr. A. homesteaded two lots on the south bank of Wolf River, on Section 36, but lays claim to a strip of land on the opposite bank, and has cut hay thereon for years. He received his patent in 1891, and wishes to know how he may obtain title to the other tract, which he regards as unappropriated. In order to give a clear understanding of the case, the following diagrams are presented: —

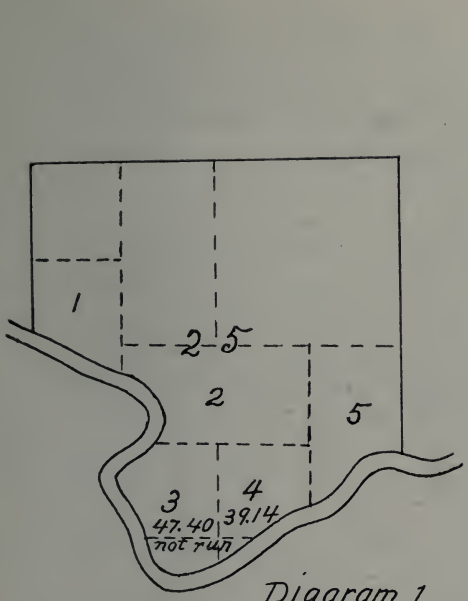


Diagram 1

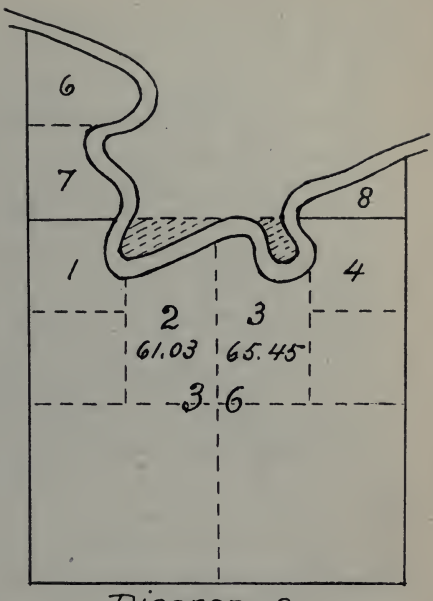


Diagram 2

Diagram 1 shows the appearance of lots 3 and 4 on the original plat, approved Nov. 25, 1844, of Ellis's survey in 1843.

Diagram 2 shows the appearance of fractional sections 25 and 36 on original plat, approved April 5, 1852, of survey made in 1852. Hatchings indicate the strip in question.

From the field notes and plat of Dr. A. G. Ellis's survey in 1843, of land in Section 25, it appears that he meandered the Wolf River far enough south to cross the line into Section 36, but did not run that section line. The surveyor general therefore constructed the plat, showing that lots 3 and 4 extend to the river, and are not limited by the dotted line marked "not run." He also reckoned in all the area of the strip in question, as shown by the figures 47.40 and 39.14. Therefore the tract was meandered and platted and delineated as a part of lots 3 and 4, in Section 25, nearly sixty years ago.

Under an act of 1854, lands were granted for the Fox River Improvement, etc., and under that act said lots 3 and 4 were selected in 1855, and selection approved in 1857. In this manner the United States parted with its title to the land in question forty-five years ago, by definite legal description, according to the plat of survey thereof.

It does not affect the title of the grantees of said lots, that in 1852 the first and only survey of the country on the opposite shore of Wolf River was made by deputies Perin and Carpenter, and that they ran and established the full line between Sections 25 and 36, setting two meander posts and a quarter-section corner on the north side. For there is only one plat, and only one arrangement of lots on the north side, and in the more recent plat no land is included or reported in Section 36, except south of the river. To all legal intents the line between the tracts belonging to Section 36 and those of Section 25 follows the river part of the way, because all titles have been given in accordance with the existing plats and vested rights have accrued. Mr. A. is informed that the United States has no land remaining vacant in that locality.

BINGER HERRMAN, *Commissioner.*

An act of Congress approved June 10, 1896, contains the following: —

Provided further, That hereafter it shall be unlawful for any person to destroy, deface, change, or remove to another place, any section corner, quarter-section corner, or meander post, on any government line of survey, or to cut down any witness tree or any tree blazed to mark the line of a government survey, or to deface or remove any monument or bench mark of any government survey. That any person who shall offend against any of the provisions of this paragraph shall be deemed guilty of a misdemeanor, and upon conviction thereof in any court shall be fined not exceeding two hundred and fifty dollars, or be imprisoned not more than one hundred days. All the fines accruing under this paragraph shall be paid into the treasury, and the informer, in each case of conviction, shall be paid the sum of twenty-five dollars. (29 Stat. L., 343.)

MICHIGAN ENGINEERING SOCIETY.

BUSINESS TRANSACTIONS AT THE TWENTY-THIRD ANNUAL CONVENTION.

The business meeting of the Engineering Society was held Wednesday evening, Jan. 8, 1902. Owing to the unfortunate accident, already referred to, by which the entire stenographer's notes of the convention were destroyed, it is impossible to give a complete report of the business transactions.

The Secretary read the annual report of the Board of Directors, which was approved by the Society, and is as follows: —

ANNUAL REPORT OF BOARD OF DIRECTORS.

The annual meeting of the Board of Directors was held at Lansing, Sept. 18, 1901. There were present, President Riggs, Secretary Hodgman, Directors Skeels and Vedder, and members Sears and Cooley.

The meeting was called to order by the President, and the annual report of the Secretary read and accepted.

The Treasurer's annual report was read and approved.

The ballots for officers were canvassed, and the following candidates were found to be elected: President, Wm. B. Sears, of Saginaw; Vice-President, M. E. Cooley, of Ann Arbor; Secretary-Treasurer, F. Hodgman, of Climax; Directors Dorr Skeels, H. E. Riggs, and J. B. Davis. The officers-elect who were present then qualified. The applications of F. B. Slocum, J. J. McVean, and P. E. Harroun for withdrawal were ganted. The memberships of W. H. Wallace, V. V. Newell, F. Tittman, O. J. Root, and A. S. Calkins were annulled for non-payment of dues. Action in the cases of E. Dennis and F. E. Skeels was deferred until the next meeting of the Board.

It was voted to hold the next annual convention at Grand Rapids, Jan. 7, 8, and 9, 1902. Papers for the convention were considered, and the Board adjourned.

F. Hodgman, *Secretary.*

The Secretary would add that since the meeting of the Board of Directors, some of our exchanges have been received and forwarded, but those from Ohio, Iowa, School of Practical Science, University of Tennessee, and Ontario have not yet materialized. The two latter may not show up at all, as nothing has been heard from either of them. The others I hope to get some time. I still get no communication from Major V. Sankey, the secretary of the Ontario Land Surveyors, and their bill of $25 remains unpaid. It looks as though Mr. Sankey was solely responsible for this state of affairs, as I have been assured by a member of their council that the bill was audited and ordered paid nearly a year ago.

The cash balance in the treasury is now $287.91, with no outstanding indebtedness. F. H.

The Secretary and Treasurer's reports referred to in the preceding report of the Board of Directors are as follows: —

SECRETARY'S ANNUAL REPORT.

CLIMAX, MICH., Sept. 17, 1901.

To the Board of Directors of the Michigan Engineering Society:

I would respectfully report the following business transacted by me for the Society since my last report. Immediately after the annual convention, I contracted with the Review and Herald Publishing Company, of Battle Creek, for two thousand copies of the MICHIGAN ENGINEER for 1901, and went to work to get what advertising patronage I could. The copy was furnished to the printers as fast as they were ready to use it, but owing to a great pressure of other business, they were unable to get the report out until the tenth of June. The ill health of the Secretary prevented him from giving the proof-reading and printing as careful attention as it required, with the result that some very annoying errors escaped correction. As the securing of advertising patronage was practically all left to the Secretary, less than the usual amount was received. The committee assisted to some extent, but owing to the feeling in the Society that an engineer cannot solicit ads. without danger of compromising himself, the Secretary did not feel at liberty to ask any assistance. He regrets that he should be looked upon as the one member of the Society who should

put himself in a position to be compromised or laid under suspicion. If he saw the matter in that light, he would never solicit another ad. for our reports; but he does not. He believes it is nothing to be ashamed of, and no crime to return a favor. When other things are equal, he always patronizes those who patronize him. Since he has been Secretary of this Society, he has had opportunities to influence orders for surveying instruments and supplies, amounting to probably one thousand dollars, and he has sent every one of these orders to our advertising patrons. He proposes to keep right on doing so as long as he can, and only regrets that he has not more opportunities.

On the first Monday in March, ballots for members were sent out to the members, and on the first Monday in April, such of them as had been returned were canvassed, and the result announced in the ENGINEER.

On the 15th of August, ballots for officers were sent out to the members. Such as have been returned, are herewith submitted for canvassing. With the ballots was sent an announcement of the annual meeting of the Board of Directors, with a query in regard to papers for the next convention. Such responses as have been received are herewith presented.

So far, the Secretary has not been able to arrange the usual number of exchanges for 1901, but hopes to do so later. Several of the societies with which we have been in the habit of exchanging publications are afflicted with secretaries who either cannot or will not attend to the duties of their offices. I have had no word this year from the societies of Ohio, Iowa, Ontario, the University of Tennessee, or the School of Practical Science. The Ontario Society has owed us $25 for more than a year. I have written their secretary, Major V. Sankey, of Toronto, repeatedly during the past year, and I can get no response whatever from him. Most of our other regular exchanges have been received, and distributed to the members who were entitled to them.

J. J. McVean, F. B. Slocum, and P. E. Harroun have applied for withdrawal. Their dues are paid up in full, and they are entitled to have their request granted.

F. HODGMAN, *Secretary*.

TREASURER'S ANNUAL REPORT.

CLIMAX, MICH., Sept. 17, 1901.

To the Board of Directors of the Michigan Engineering Society:

Your Treasurer would respectfully report as follows for the past year: —

RECEIPTS.

Cash on hand, Sept. 19, 1900	$225 36	
Received for annual dues	334 00	
Received for advertising	298 59	
Received for membership fees	60 00	
Received for Reports sold	36 00	
Received for postage on exchanges	53 00	$1,006 95

EXPENDITURES.

Paid for 2,000 MICHIGAN ENGINEERS for 1901	$301 80	
Paid to Secretary, as voted by the Society	225 00	
Paid for postage stamps	101 50	
Paid for stenographer	39 55	
Paid for miscellaneous printing	27 50	
Paid for expenses of Board of Directors	20 00	
Paid for freight, express, and dray	11 73	
Paid for Secretary's expenses on ENGINEER	4 00	
Paid for commission on ads	5 00	
Paid for *American Digest*	4 00	
Paid for copyright	1 15	
Paid for collection fees	95	
Paid for envelopes	1 50	
Cash on hand, Sept. 17, 1901	263 29	$1,006 95

The Society owes nothing. There is due it from advertisers: —

From Jeffrey Mfg. Co.	$16 00	
From Cast Iron Pipe & Foundry Co.	15 00	
From G. N. Saegmuller	5 00	
From Russell Wheel & Foundry Co.	4 00	$40 00

There is due from —

7 members who are 1 year in arrears for dues	$21 00	
8 members 2 years in arrears	48 00	$69 00

There are seven members more than two years in arrears for dues, whose membership should be annulled, unless satisfactory reasons are given to the contrary. With the exception

of F. Tittman, who is supposed to be in a foreign country, they have all been notified, as required by our by-law. They are: W. H. Wallace, E. Dennis, V. V. Newell, F. Tittman, O. J. Root, A. S. Calkins, and F. E. Skeels. All except Mr. Tittman have also been written to repeatedly, and no reply has been received from any of them.

There is due the Society from the Association of Ontario Land Surveyors, $25, for extra copies of the MICHIGAN ENGINEER for 1900. I have been informed by a member of that society, who is in a position to know, that the bill was approved and ordered paid last winter, but the secretary-treasurer of that society holds it, and does not reply to my letters.

F. HODGMAN, *Treasurer.*

Subscribed and sworn to before me, a notary public for Kalamazoo County, Michigan, this 17th day of September, A. D. 1901. CLEMENT B. GUCHESS, *Notary Public.*

Nominations for officers to be elected by letter ballot were made as follows: —

For President — Prof. M. E. Cooley, of Ann Arbor.

For Vice-President — A. L. Holmes, of Grand Rapids.

For Secretary-Treasurer — F. Hodgman, of Climax.

For Directors — A. C. Lane, of Lansing; J. B. Davis, of Ann Arbor; W. W. Brigden, of Battle Creek; B. E. Parks, of Detroit; Dorr Skeels, of Grand Rapids; and H. K. Vedder, of the Agricultural College.

On motion of A. L. Holmes, it was voted that we pay the Secretary three hundred dollars for his services the past year.

It was voted that A. C. Lane be added to the Committee on Forestry.

Geo. M. Ames resigned from the Committee on Roads and Paving, and Frank F. Rogers was appointed in his place.

Mr. Brigden presented an invitation to hold the next convention at Battle Creek.

The Committee on "Topographical Survey of the State" reported as follows, and the report was accepted: —

REPORT OF COMMITTEE ON "TOPOGRAPHICAL SURVEY OF THE STATE."

GRAND RAPIDS, MICH., Jan. 7, 1902.

To the President of the Michigan Engineering Society:

Your Committee, to whom, at the last annual convention of this Society, was intrusted the duty of preparing a memorial to the Legislature of Michigan, asking that an appropriation be made for commencing a topographical survey of the State, would respectfully report that they duly performed this duty, by preparing a memorial, a copy of which is hereto attached, and which embodied the combined suggestions of the several members of the Committee and of Professors Alfred C. Lane and Isaac C. Russell.

A copy of this memorial was presented to each branch of the Legislature, was printed in the *Senate Journal,* and referred to the proper committees, and for a time it was strongly hoped that the meritorious character of the measure for which it asked would have secured it at least a respectful consideration, but, so far as can be learned, like every other measure which this Society has advocated before our Legislature, it seems to have found a peaceful grave in the archives of the committees, and has never since seen the light. This result is discouraging, and it will be a full year before another effort can be made; but the measure is one of such great importance, and so deserving of success, that this Society should not cease its efforts until a Legislature is elected which can be made to understand that we are laboring not for our own benefit, but for the public good.

It will, however, no doubt be gratifying to the Society to learn that, while its appeal to the Legislature has been in vain, its labors have not been entirely without fruit. Through a fortunate concurrence of circumstances, Prof. Alfred C. Lane, our State geologist, after laboring most faithfully, but unavailingly, with the Legislature for a specific appropriation, was enabled to set apart a portion of the regular appropriation for the State Geological Survey for this purpose, and to make an arrangement with the directors of the United States Geological Survey for the survey of a quadrangle included between parallels of latitude 42° and 42° 30′, and of longitude 83° 30′ and 84°, includ-

ing the cities of Ann Arbor and Ypsilanti. The field work of this survey was prosecuted for several weeks during September, October, and November last, and will be completed in the coming spring. It has been the hope of Professor Lane that this modest beginning might prove an object lesson, and being executed under the eyes of the great bodies of students at the University and the Normal College of Michigan, might, through their instrumentality, become widely known throughout the State, and thus help to mold public sentiment in favor of its continued prosecution. In this hope we can all most heartily join. A copy of a communication showing the progress of the work thus far is hereto attached. E. W. MUENSCHER, *Chairman.*

MEMORIAL.

To the Honorable, the Senate and House of Representatives of the State of Michigan:

We, the undersigned, having been appointed by the Michigan Engineering Society a committee to represent to your honorable body the advantages and advisability of a topographical survey of the State in conjunction with the United States Geological Survey, would respectfully represent —

1. That no topographical map of the State of Michigan, and, in fact, no map of the State worthy of the name, now exists or can be compiled from existing surveys.

2. That such a map cannot be constructed except as the result of an accurate topographical survey.

3. That much money is wasted every year in re-surveys, owing to the lack of a general compilation of past surveys in a convenient map.

4. That the increase and extension of systems of land drainage and irrigation imperatively demand a contour topographic map, by which alone they can be planned in a systematic and efficient manner.

5. That provisions for systems of sewerage for our growing towns are greatly aided by topographical maps.

6. That they are an absolute necessity before intelligent judgment can be given between various projects of water supply for towns, and for this use alone they might well be worth all that they would cost.

7. That they are a prerequisite for the scientific study of our water powers and of those areas which should be preserved for forest culture at the head waters of our streams in order to prevent the depletion of these water powers.

8. That they would aid immensely in securing the best locations for railroads, both steam and particularly the electric roads which will eventually gridiron the State, and would save large sums of money which would otherwise be spent for preliminary surveys or useless construction, the interest on which the people of Michigan would have to pay.

9. That they would be of great value to both the sellers and purchasers of land, by showing the character of the surface, whether level or hilly, wet or dry, timbered or cleared, well or poorly watered.

10. That they would be of the greatest value and interest in the teaching of physical geography in our public schools.

11. That the establishment of a true meridian line in every county, which is part of the proposed work, would go far toward diminishing the litigation which arises out of erroneous surveys due to variation of the magnetic needle, and the establishment of permanent bench marks in every township, referred to a common datum, would be of great value to land-owners in planning extensive systems of drainage.

12. That a topographic map of Michigan, once available, would be copied by map publishers, and accurate information concerning the State would thus be widely disseminated.

13. That such a map would be one of the best means that the State could use for making its resources and its facilities for manufacturing, transportation, etc., etc., known to parties outside its borders who are looking for investment, sites for factories, etc., etc.

14. That such a map is an absolutely necessary basis for the geological survey of the State, which is so necessary for the development of its natural resources, and the State cannot expect the assistance of the United States government in such survey until such a basis has been provided.

For the above reasons, therefore, and many others which might be suggested, which we as engineers directly appreciate, we respectfully ask your honorable body to make provisions for

the commencement of such survey. And we would suggest that co-operation with the United States government, as provided in House Bill No. 139, would be the most economical way of attaining the desired object. The experience of other States has shown that with such co-operation the cost of the survey to the State would be less than one third of what it would be if undertaken by the State alone, since the State would only have to pay one half the cost of the field work alone, and this can be done by the trained and experienced employees of the United States Geological Survey at much less expense than by the untrained men whom the State would have to employ, and the results of all previous surveys by the general government would be utilized.

The United States would bear the entire expense of engraving and publishing the maps, and these maps can be furnished so cheaply that every school district in the State can obtain for a few dollars accurate maps of the entire State, and for a few cents those of its immediate neighborhood.

Prompt and favorable action in this matter is especially desirable, for the reason that several other States are preparing to accept the offer held out by the general government, and, as this offer is limited to the amounts appropriated by Congress, any delay on the part of the State of Michigan might result in the loss of the opportunity for many years.

E. W. Muenscher, Manistee,
E. S. Wheeler, Detroit,
J. E. Jopling, Ishpeming,
J. Ripley, Sault Ste. Marie,
H. K. Vedder, Lansing,
Committee of Michigan Engineering Society.

Department of the Interior, United States Geological Survey.
Washington, D. C., Feb. 4, 1901.

Prof. Alfred C. Lane, State Geologist Michigan, Lansing, Mich.

Dear Sir: Referring to your letters of January 30 and 31, asking as to the organization of field parties, etc., I will make the following statement, which covers the whole case in a general way: —

The State of Michigan contains a little less than 59,000 square miles, which, at the average rate of $8 per square mile, as mentioned in my letter of the 19th ult., would cost $472,000. The Upper Peninsula and the northern part of the Lower Peninsula being more or less densely wooded, and covering an area of about 36,000 square miles, I estimate would cost at the rate of $10 per square mile. The southern part of the Lower Peninsula — about 22,500 square miles — would cost at the rate of $5 per square mile, making the average cost for the whole State $8 per square mile.

The field work of the two districts would require an entirely different organization. The parties working in the wooded and sparsely settled districts would necessarily be obliged to live in camp, and beside the regular employees for topographic work there would be woodsmen, packers, etc., the work being done entirely on foot. In the settled and open districts of the Southern Peninsula the field parties would live at hotels and farm houses, and would employ only the necessary topographic assistants for carrying on the work, all except the level parties, using hired conveyances.

I inclose with this plans of organization for field parties, which would apply to each district mentioned, and which will show also, in a general way, the method of equalizing expenditures in field and office work. The number of such field parties, of course, would depend upon the whole amount available for the year. Each party would be in charge of a topographer from this office, and in some cases there would be attached an assistant topographer, also from this office. The temporary field assistants are chosen preferably from those resident in the State, provided of course that they fulfill the conditions required for the work upon which they would be employed.

Very respectfully,

CHAS. D. WALCOTT, *Director.*

Michigan, Lower Peninsula.

ONE FIELD PARTY, SIX MONTHS.

EXPENDITURES.

	Geological Survey.	State of Michigan.
Salary of topographer in charge, 6 months at $1,800	$ 900 00	
Monthly pay temporary field assistants for same time — levelman, $60; rodman, $35; 2 traversemen, $120	1,290 00	
Subsistence 5 men, 6 months		$1,800 00
Livery 3 men, 6 months		900 00
Traveling and miscellaneous expenses	200	
Supervision	400	
Salary topographer in office work, 6 months	405	
	$3,195 00	$3,195 00

Total cost of field and office work for year.....$6,390 00

This party would be expected to survey 1,300 square miles on a scale of 1 : 125000, with a contour interval of twenty feet, at the rate of $5 per square mile.

Total cost of field and office work for year.....$7,100 00

ONE FIELD PARTY, SIX MONTHS.

Michigan, Upper Peninsula.

EXPENDITURES.

	Geological Survey.	State of Michigan.
Salary topographer in charge, 6 months at $1,800 per annum	$ 900 00	
Salary ass't topographer, 6 months $1,000 per annum	500 00	
Monthly pay temporary field assistants for same time — levelman, $70; rodman, $35; 2 compassmen, $90; cook, $45; 4 axmen, $160		$2,400 00
Subsistence for whole party, 6 months		1,000 00
Traveling and miscellaneous expenses, including new outfitting	500 00	
Supervision	400 00	
Salary topographer and ass't topographer in office work, 6 months	1,250 00	150 00
	$3,550 00	$3,550 00

This party would be expected to survey about 700 square miles on a scale of 1 : 125000, with a contour interval of twenty feet, at the rate of $10 per square mile.

United States Geological Survey.

WASHINGTON, D. C., Dec. 31, 1901.

DEAR SIR: Referring to my formal agreement with you for the execution of a co-operative topographic survey of a district in the vicinity of Ann Arbor, Mich., by the terms of which agreement you contributed $2,000, provided that this survey would expend an equal amount upon the same work, I have to make the following report: —

Immediately following the signing of the agreement, Mr. John H. Renshawe, geographer, in charge of the Central Section of Topography, was authorized to begin the preparation of plans for field work. Mr. George T. Hawkins, topographer, began work on the horizontal control for the district on August 21, and continued until September 3, during which time he ran 116 miles of primary traverse, starting at the triangulation station of the United States Lake Survey at Tecumseh, tying with the astronomic position at Ann Arbor, thence to Detroit, where he connected with the primary position of the United States Lake Survey.

Mr. Robert Muldrow, topographer, was placed in charge of the topographic field work, which was commenced September 2, and was prosecuted without interruption until the end of November, during which time 110 miles of primary spirit levels were run, based upon the precise datum established by the United States Coast and Geodetic Survey at Gibraltar, and 292 square miles of topography were completed on a scale of one mile to the inch, with a contour interval of twenty feet. The topographic work completed lies in Townships 1 to 3 south, inclusive, Range 6 east. The field work was necessarily slow on account of the complicated glacial forms in the vicinity of Ann Arbor.

From your contribution there has been expended in field work, as shown by the vouchers which have been sent you, $1,012.65, against which this survey has expended from its own funds for the permanent salaries of Messrs. Hawkins and Muldrow, and for traveling expenses to and from the field, the amount of $601.41.

Field work will be resumed as soon as the weather will per-

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Hazen, Allen, St. Paul Bldg., New York.
Masson, Geo., Detroit, Mich.
Steele, Geo. E., Los Angeles, Cal.
Watkins, John J., Guthrie, Oklahoma.

SENIOR MEMBERS.

Albertson, Dan. J., Kalamazoo, Mich.
Anderson, H. C., Ann Arbor, Mich.
Ames, Geo. M., Grand Rapids, Mich.
Baker, S. Harlan, Manistee, Mich.
Bailey, M. H., Dimondale, Mich.
Barrington, Edward, Tierra Blanca, Vera Cruz, Mexico.
Barrally, T. W. (Unknown).
Bean, Henry F., Jackson, Mich.
Beckmann, L., Toledo, Ohio.
Bement, Clarence E., Lansing, Mich.
Blair, James, Adrian, Mich.
Bradt, J. C., Marcellus, Mich.
Bradt, E. F., Ishpeming, Mich.
Brigden, W. W., Battle Creek, Mich.
Bristol, Geo. F., Grand Rapids, Mich.
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Brown, Geo. M., Saginaw, E. S., Mich.
Campbell, Henry, Poplar Bluff, Mo.
Carpenter, L. G., Fort Collins, Colo.
Cavis, C. H. V., Marquette, Mich.
Courtright, P. A., Marshall, Mich.
Cooley, M. E., Ann Arbor, Mich.
Cummings, Geo. P., Marquette, Mich.
Cummings, Chas., Marquette, Mich.
Davis, J. B., Ann Arbor, Mich.
Denison, Chas. S., Ann Arbor, Mich.
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Johnston, H. A., Kalamazoo, Mich.
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La Rue, Benj. F., Scranton, Pa.
Lane, Alfred C., Lansing, Mich.
Mark, Geo. A., Hillsdale, Mich.
Mason, Carlisle, 10 Wall St., New York.
McCormick, R. S., Owen Sound, Ontario.
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Millard, Jas. H., Houghton, Mich.
Mitchell, C. E., Ludington, Mich.
Mitchell, J. A., Ludington, Mich.
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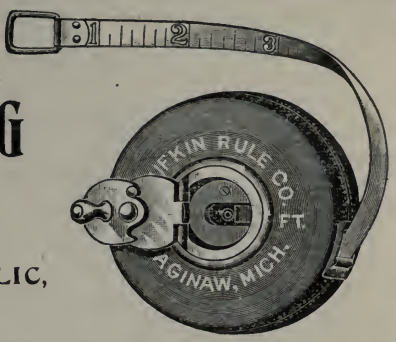

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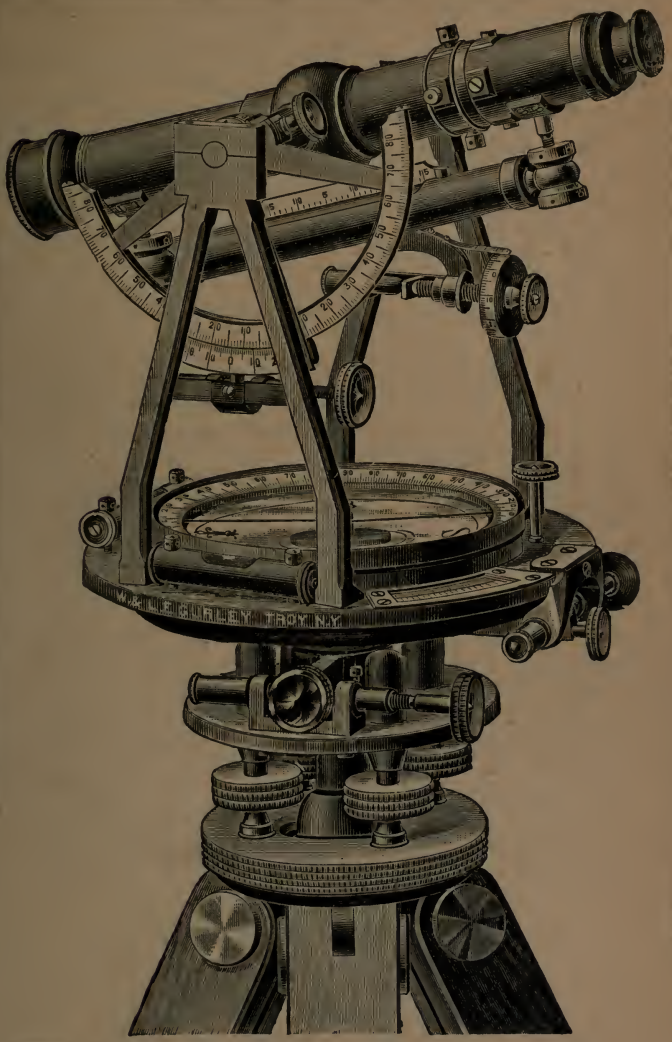

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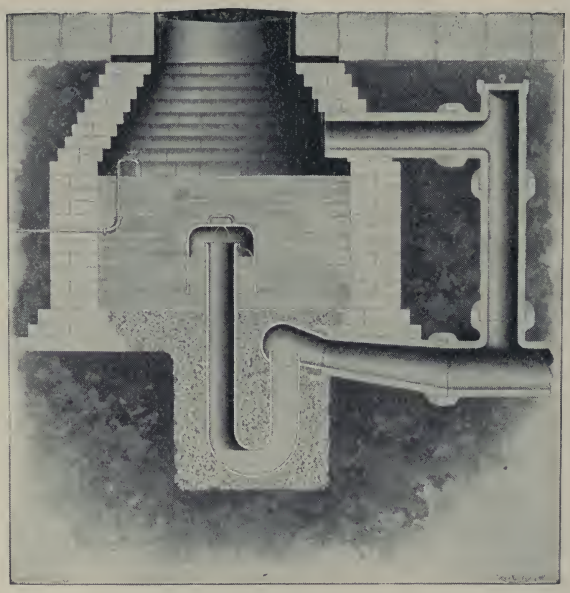

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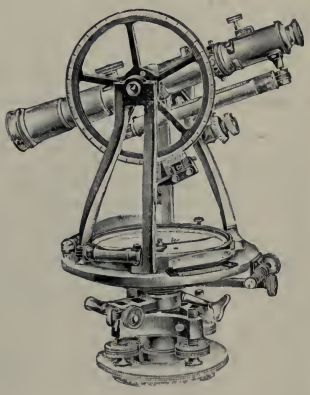

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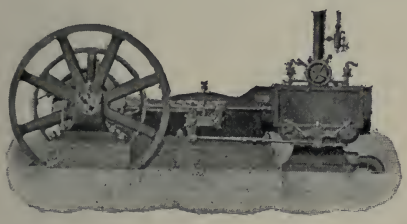

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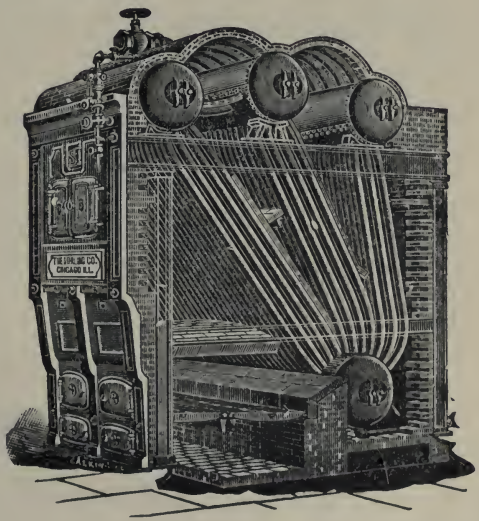

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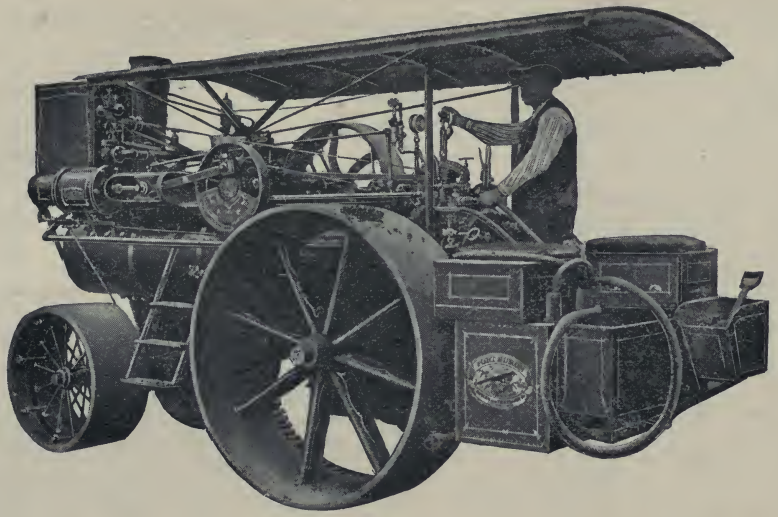

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Michigan Engineering Society.

The Twenty-fourth Annual Convention of the Michigan Engineering Society was held in Battle Creek, at the Y. M. C. A rooms, January 20, 21, and 22, 1903, with a large attendance and a full program. President M. E. Cooley, of Ann Arbor, opened the Tuesday evening session with the following address:

ENGINEERING GOSSIP — FAMILY MATTERS.

M. E. Cooley.

Father Progress and Mother Necessity had two sons, the military and the civil engineer. Only a limited progeny descend from the military engineer, but the civil engineer has a large family. The elder son of this family is the land surveyor. He has proven to be an individual of long life, and is still with us in a vigorous manhood, showing no appreciable decay; still eager as he has always been, in the pursuit of that lost corner, in picking up those mysterious lines, and in locating the boundaries of our individual realms. He is, and always has been, and always will be, a man of importance, a man whose word is accepted as final in important controversies, a man upon whom the courts rely for the facts that enable them to judge fairly in an important class of litigation; in short, an indispensable man. This elder brother has been a pioneer, and has to do with the earliest history of our country. Indeed, it is to him we owe the first work that has led to our modern civilization.

One is thrilled to hear the tales of these early pioneers, and to learn of the hardships which they suffered in pursuing their work, either alone or as a little band far remote from civiliza-

tion. Our country's archives are filled with the records of these men, and these records must remain among our most valuable and permanent possessions. No attempt will ever be made to disturb this great work. Even the modern trend toward the metric system, which has been agitated so persistnetly for the past few years, has excepted the records of the land surveys which must remain in the original units.

Among the earlier associates of the land surveyor were the hydraulic and mining engineer. The use of water, and mining operations, are very old in the history of the world. Mining dates back a considerable time as a separately titled profession, while the hydraulic engineer still clings to the family initials, preferring to use the explanatory clause to further define his specialty.

So it is also with the railroad, the municipal and the bridge engineer. Occasionally the sanitary engineer dons a high hat of his own with distinctive initials; but all of these, and many others, belong to the same line of the old family and are to-day known as civil engineers.

Among the descendants of the mining engineer we find the metallurgical engineer, followed more recently by the chemical engineer, who, before he has yet fairly reached his teens, brings forth the electro-chemical engineer, an infant with lusty lungs crying for recognition. With this rapid development, what may we safely predict will be the result of further intermarriage among these cousins?

The naval and the marine engineer have long been known to us as descendants of the military engineer. The marine engineer, however, probably owes his prominence more to the mechanical engineer than to any strain inherited from his earlier ancestor.

Among the well known descendants of the old family of civil engineers is the mechanical engineer. It is of comparatively recent date that he has got into his frock coat, and with a high hat, gloves, and a stick, tried to make the world believe he has always been. He already shows up well with a number of sons who still use the family crest, and it is to these sons I purpose devoting considerable of my time this evening. One

son, the electrical engineer, has already come to the front with a dazzling glare and with an aurora borealis effect which leaves us wondering what the morrow will bring forth.

The earlier mechanical engineers grew up in the shops. Some of them were civil engineers with shop training. There was little literature in this particular profession in its earlier days, if we except the steam engine and the few old books, of which Rankine's Machinery and Mill Work and Fairbairn's are examples. It is only within the last quarter of the century just closed that the mechanical engineer has really come to take a permanent and distinctive place in the engineering world.

The past twenty-five years have witnessed a wonderful development of facilities for preparing men for the engineering profession. Half a century ago the engineering schools of this country numbered less than half a dozen. To-day there are hundreds. Each of the branches of the profession has a well-defined curriculum of studies taught by trained experts, and the number of graduates annually turned out is very large. Notwithstanding the large number of graduates to-day there are not sufficient to go round; constant applications are flowing into all our engineering schools for trained young men; the demand far exceeds the supply.

It is significant that while ten years ago technical graduates were looked upon askant by their employers, especially in mechanical engineering, and it was often said of them that they were not so valuable to their employers because they lacked practical experience, to-day the employers say, "We do not ask for experienced men; all we want is men who have had a technical training; we will give them the experience ourselves." For several years past, and again already this year, some of our larger industries have sent in requests for men, saying that they can use the whole of the graduating class in certain lines of work. In some of our schools there are standing requests preferred by the very largest industries of this country, for the brightest of our graduates. To these are promised any advancement they may command by their energy and ability. We may well pause and ask the meaning of this phenomenal demand for technically trained young men. Some will say the growth of the country

demands it; others that the growth of the country has resulted from it. We may safely assume that the growth of the country and the development of our engineering professions are mutual, one being dependent upon the other.

No country excites the interest of the world to-day more than our own; and in England they point to our professionally trained men as the source of our tremendous development.

In the full tide of our progress, in which we are all carried on together, few of us realize just how significant the work of the engineer stands in its relation to the world. Suppose, for example, we were to be deprived of many of the other professions, the world would still go on; there would be some inconvenience, some suffering, and some death. Remove from the world for a single day all of the engineers, and the machinery which they command, what would be the effect? The world would stop.

I trust I may be pardoned if I invite your attention for a moment to the important part which mechanical engineering plays in the progress of the world to-day. Scarcely a work of any importance is now ever undertaken except the aid of machinery be involved. These are no longer the days of Paddy and his wheelbarrow in executing the projects of the civil engineer; he now needs the steam shovel and the derrick. No longer does he employ the slow process of hand hammer and drill with blasting powder for rock excavation, but he has the fast air-driven rock drill and dynamite to speed his work along. No longer is he wholly dependent upon careful curbing for his underground work, but he now drives his tunnels by the use of compressed air, by freezing the treacherous quicksands with some one of the modern processes of mechanical refrigeration.

The mining engineer makes use of machinery for much of his underground work. Not only are the ores excavated and brought to the surface by machinery, but they are there crushed and passed through their entire treatment largely by mechanical means. In all manufacturing processes do we find machinery used in some form or another. It has now become the bone and sinew which accomplishes most of our operations. I am sometimes prone to think that mechanical engineering stands

in its relations to the work of other engineering professions much in the same way that mathematics stands to all of the engineering professions. It is now a necessity in the accomplishment of results for all of us, in a greater or less degree.

The mechanical engineer, from being a man with a moderate amount of scholastic training, with a large amount of practical shop experience, has come to require a thorough theoretical training as well as a knowledge of shop methods. His work is no longer limited to a few lines; it has broadened out in many ways, and to-day he is not only engaged in the design of general machinery for manufacturing purposes, he is also engaged in the study and design of steam machinery, gas engines, compressed air, mechanical refrigeration, and hydraulic machinery.

It will be interesting to note the development along these latter lines. We think of the steam engine as a very old machine and speak of it as of the time of Watt, which was about the time of our revolutionary war. It is true that for the first half of the last century only a little progress was made. The period of our war of the rebellion witnessed a considerable development, notably that of the Corliss engine. It was not until about 1875 and 1880, however, when the ocean greyhound and electricity on a commercial scale were being brought forth, that the steam engine commenced to make its rapid strides; and the last twenty-five years has witnessed a wonderful change. In the days of Watt a cubic foot of water was required to produce a horse-power every hour. This was over sixty pounds. The average engine gave us a horse-power twenty-five or thirty years ago for about one-half of this amount, or say thirty pounds. For the past ten or fifteen years we have been getting a horse-power for fifteen and twenty pounds per hour, and to-day we are getting a horse-power for from eleven to fifteen pounds, with an occasional record of a horse-power for less than ten pounds.

The steam turbine has in the last five years demonstrated its worth and created for itself a place in the world. The steam turbine is very old, dating back to Hero, of Alexandria, 140 B. C. Two thousand years have passed and it has remained to the last

five years to see it perfected to such a state as to give us a horse-power comparable with the best piston-engine practice.

But little more than fifty years ago the gas-engine first made its appearance. It was a crude machine, built on the lines of the steam-engine. The first of these machines required from 125 to 150 cubic feet of gas for each horse-power per hour. During the centennial year this machine was brought out in a more perfect form known as the Otto-Langin type, which gave us a horse-power for about fifty or sixty cubic feet of gas. This engine was extremely noisy; it was speedily followed by the so-called Otto-silent gas-engine, with a gas consumption of from 30 to 35 cubic feet of gas per hour. These gas-engines were at this time of small power, less than fifty horse-power, yes, less than twenty-five, and it was not thought they would ever be available for large power. To-day, however, we have gas-engines of 600 and 1,000 horse-power, and the consumption of gas is as low as fifteen cubic feet per horse-power per hour with instances approaching ten cubic feet. Even this is not the limit; we are no longer confined to the use of gas similar to illuminating gas; producers are being brought out which make use of hard coal and of soft coal slack or refuse. On a recent contract for a number of large engines of from 500 to 1,000 horse-power the producers were guaranteed to deliver 10,000 British Thermal Units (B. T. U.'s) for each one pound of coal. This corresponds to an efficiency of 75 or 80 per cent, which is quite comparable with, or even better than, the average steam-boiler efficiency. In the same contract the engine men have guaranteed to produce a horse-power per hour for 14,000 B. T. U.'s. This means a horse-power on 1.4 lbs. of coal, which is better than is obtained with the steam-engine, excepting in the very largest sizes and with the most elaborate provision for the utilization of all waste heat. The producer man, while he has eguaranteed only 10,000 B. T. U.'s per pound of coal, fully expects to gove 12,000, and the gas-engine man expects to produce a horse-power on 12,000 B. T. U.'s per hour. This means a horse-power with one pound of coal, and with coal of inferior grades at that. I think it perfectly safe to predict for the gas-engine a horse-power on from one-half to three-quarters of a

pound of coal per hour. It must not surprise us to find that "red, blue, green or yellow devil," the modern automobile will add great impetus to the development of the gas-engine.

It has been a favorite belief of mine that compressed air was susceptible of much more economical use than is now shown for it. Compressed air is to-day being used for a multitude of purposes not dreamed of a few years ago. Very many of our shops are equipped with it for use in hoisting operations and in driving tools, and it now replaces hand operations in the pneumatic chipping and cauking tools. The modern railroad train would not be possible in the sense that it is to-day except for compressed air as used in the air-brake. One of the uses for which it might be utilized to advantage is the transmission of power. Thus far for this purpose the pressures have been only moderate, and the air transmitted has been worked in ordinary cylinders not especially adapted for economy. It will surprise many of you to learn that under 3,000 pounds pressure from 300 to 400 horse-powers can be transmitted a distance of two miles in a 3-4 inch pipe. Curiously enough the loss by this transmission is very slight and may not exceed 2 1-2 per cent. The air delivered when reconverted into power gives a result but slightly less efficient than a similar amount of power transmitted by electrical means, and if the air after being used in the working cylinders be used in connection with cold storage, the economy has become surprisingly large. The future of compressed air appears to me to be very bright, and a small part of the brain, effort, and money support that is now given to electrical subjects would soon give compressed air a place in the world not now accorded it.

Another branch of engineering to which little or no attention has been given in our scientific schools, is mechanical refrigeration. This is coming to be recognized during the last five or ten years. We have such an abundance of natural ice on all sides of us that we scarcely ever think of making ice by artificial means. But were the time at my disposal I could demonstrate to you that in the city of Toledo artificial ice can be manufactured and marketed at less expense than is now incurred for natural ice brought from the southern lakes of Michi-

gan. Not only this, but the artificial ice would be freer from impurities and far more wholesome for household use. But the manufacture of ice is perhaps the least important of the uses to which mechanical refrigeration can be put. Cold storage is a great field for it, and when it is better understood, cold storage warehouses will be found in every town of importance where the preservation of foods may be necessary or desirable.

Hydraulic machinery is a branch of engineering which has experienced remarkable development during the past decade. I refer both to pumps and to water-wheels. Twenty years ago a duty of from 50 to 75 millions foot-pounds of work per each 100 lbs. of coal was considered remarkable, and when 100 millions was reached it marked an epoch in the development of pumping machinery. To-day, however, we are getting duties of from 150 to 160 millions. For handling large volumes of water and for pumping of sewage centrifugal pumps have been largely used. An efficiency of from 50 to 60 per cent has been considered good for this class of pumps. Very recently centrifugal pumps have been developed so that we may now expect efficiencies of from 70 to 75 per cent. There is still room for improvement with this class of pumps.

Among the water-wheels we have also experienced very great improvement. Water-wheels in a crude form were used in very early times; the old vertical wheel long ago disappeared except in out-of-way places. During the middle of the past century, and even up to near the end of the century, comparatively little use was made of water-wheel machinery. To-day, however, water-power is being produced on a very large scale, and the efficiency of these machines is exceedingly high. It is hard to realize that we have, for so many years, neglected the abundant supply of power at our doors in favor of coal transported for great distances and at high cost. That which has brought the water-wheel to the front during recent years is undoubtedly the development and transmission of electrical energy; it has brought even the remote waterfall close to our doors. Few of us realize that the wonderful development of the Pacific Slope is due to the utilization of only a portion of the vast water-

power in its adjacent mountains. We have but just begun in the development of the water-powers of this country.

I now come to speak of our new engineering building at the University of Michigan. We have in process of erection a building which will probably cost, before being completed and fully equipped, from two hundred to two hundred and fifty thousand dollars. The University has long needed increased facilities for its engineering work. The number of students coming to the institution is now about six hundred; the freshmen class alone numbers about three hundred. Our old facilities were entirely inadequate for one-half the number of students we now have, and if the number continues to increase, we may, I think, need additional room before our new quarters are completed.

We are striving to equip this new building in such a way as will afford our students facilities for studying the modern problems in engineering. We not only wish to give the solid foundation for which the University has always been noted; we wish also to bring these young men into contact with modern methods and modern machines, with abundant opportunity, besides, for them to engage in research work. We hope to find among our young men some who will be able to help fill in the missing links required to bring to the highest stage of development machinery and processes now only moderately efficient.

We hope to have steam-engines, working under 500 lbs. pressure and with super-heated steam. We also expect to have steam-turbines of the different kinds, and to help toward the data needed to establish the best conditions for this class of machinery. We hope to have compressed-air machinery working under 3,000 lbs. pressure, both machines for compressing air and for using it expansively.

Wehope to have the different mechanical refrigerating processes which will afford opportunity not only for the study of these machines, but also for the study of the effects of cold upon the various engineering materials.

We hope also to have centrifugal pumps and rotary pumps, and water-wheels both of the turbinetype and of the jet type.

Provision is also being made for conducting a series of experiments upon the flow of water on a moderately large scale over weirs and through orifices, and over submerged dams and in pipes. One feature of this hydraulic work will be tanks holding at least 600 cubic feet, which will admit of making absolute measurements of the water discharged.

I trust that when our Society next meets we shall be able to lay before you in more definite form just what facilities the University will be able to afford for work along new and advanced lines.

We hope to offer such inducements as will command the interest of members of this Society, and bring those of them who may wish to investigate along some particular lines, to the University to make use of the apparatus there provided.

I can assure you all of a warm welcome, and of every encouragement and assistance to make your work successful.

NAVAL ARCHITECTURE AND MARINE ENGINEERING AT THE UNIVERSITY OF MICHIGAN.

H. C. Sadler.

For some time past the University of Michigan has offered courses of instruction in Naval Architecture and Marine Engineering, and was in fact one of the first universities to pay attention to these subjects.

Two years ago, owing to the revival of the shipping industry on thecoast, and the great increase of the same on the Lakes, the University authorities decided to inaugurate a special department for Naval Architecture and Marine Engineering. It was thought, therefore, that a short account of the training given to students in this branch of engineering might prove of interest to members o this Society.

Before proceeding to do so, it may be well to consider in the first place the connection between these subjects and the other branches of the engineering profession, as this has an important bearing upon the line of work followed.

It is generally agreed that the preliminary training of all engineers should be the same up to a certain point. A sound knowledge of mathematics, physics, and chemistry forms the groundwork for all.

At the commencement of his college career, the student is also required to study certain subjects which, in his ignorance of their value, or in his desire to rush into those studies which bear immediately upon his profession, he is apt to look upon as useless. I refer especially to the languages, French and German.

An engineer, if he wishes to keep himself up to date in his profession, should have a knowledge not only of what is being done at home, but also abroad. France and Germany possess many able engineers and scientists, who, unfortunately for the Anglo Saxon, have a habit of writing their books or articles in their native language. In naval architecture especially, the

French works are perhaps the most complete, and comparatively few have been translated.

The study of English language and literature should also form a part of the preliminary training of all engineers. One has only to glance through some specifications to see how sadly this has been neglected in certain cases. It should also be remembered that the engineer has to meet with people in all walks of life, and should therefore have interests in other matters besides those purely professional.

The connection between the chemical engineer and the naval architect may not appear at first sight to be a close one. I need not point out to engineers the necessity of keeping steel structures in a thorough state of repair. The question of oxidation is brought home to the naval architect more forcibly than to any other engineer, as his structures must spend their existence in one of the most powerful oxidizing agents. In connection with the boilers of a vessel, the composition of the water used, and the best means of preventing rapid deterioration due to harmful deposits or oxidation, are questions which a knowledge of chemistry and the composition of paints is essential. Closely connected with the above are the metallurgist and mining engineer. He would be unworthy of the name engineer who did not understand the properties, both chemical and physical, of the various metals he is called upon to use. The question of the composition and calorific value of various kinds of fuels, as well as the general consideration of combustion, has also an important bearing upon the efficiency of a power installation.

The numerous applications of electricity have brought the electrical engineer into close contact with the naval architect. Few, if any, of the modern vessels, be they of the first-class passenger or purely cargo type, rely upon anything but electricity for their illuminating power. The electric light installation in a modern large passenger vessel or warship is a serious problem. The numerous circuits, the confined space, the various conditions as to watertightness of compartments, are a few of the many items where these two members of the engineering fraternity are brought into close relations. Many other applications of electricity as a motive power for auxiliary purposes,

such as ventilating and stokehold fans, ash hoists, windlass, steering gear, ammunition hoists, etc., have become common within the last few years. Up to the present time electricity as a motive power for the ship herself has not had a very wide application, being confined to small yachts and submarine vessels. One of the principal drawbacks has been the excessive weight of the installation, but there is no saying what the future may bring forth.

The civil engineer and the naval architect meet upon the common ground of stresses in structures. Problems relating to these in connection with a ship are handled in a similar manner to those of a bridge, with this difference, however, that the civil engineer has something solid and fairly definite upon which to work for his supports, while the naval architect must design his structure so that it will be strong enough to withstand any stresses that may come upon it due to a variable, and in many cases indefinite, system of supporting process.

A ship in the same manner as a bridge is made up of a number of members riveted together; hence all problems relating to this important part of structural steel work must receive the same amount of attention in both cases.

The question of surveying and the use of instruments connected therewith, although not of primary importance, should nevertheless be studied by the naval architect, as this is brought into play in connection with laying out shipyards, docks, wharves, etc.

The connection between the mechanical engineer and the naval architect is perhaps the most intimate. At the present day in all large establishments the two departments, namely, that connected with the vessel proper and that with the design and construction of the machinery, are kept separate. This is only as it should be, as there is sufficient study in each to occupy the whole attention of one man. It is, however, necessary that each should have a thorough knowledge of the other's work. In all questions relating to the type of engine, or boiler, general design, weight, and space occupied, coal consumption, etc., the knowledge of these as possessed by the naval architect should be second only to that of the marine engineer; and in those re-

lating to the general design and structure of a ship the latter's knowledge should be practically the same as that of the former. When this occurs the naval architect will not be tempted to look upon the machinery of a vessel as a necessary evil for which space must be provided (the smaller the better), perhaps to the detriment of some of the artistic qualities of his design, and the engineer will not look upon the ship merely as a structure designed for the sole purpose of carrying his machinery.

Friction between those two is often only too common in practice; but if each possesses a knowledge of the other's difficulties and necessities there is a better chance of them working together harmoniously.

Mention has already been made of the many auxiliaries that a vessel must carry, in the shape of capstans, winches, pumps, windlass, etc., each of which is a machine in itself and should receive the same amount of attention as the other parts of the machinery. Even in a cargo vessel the name of these is legion, while in a warship they occupy so much space that the inside of such vessels has been aptly described by Kipling as "the heart of an eight-day clock."

The demand for comfort upon the sea similar to that of the best hotel on shore, has introduced many complications in the design of a ship, for information concerning which the naval architect must turn to the mechanical engineer. Such installations as heating, ventilation, sanitary arrangments, and refrigeration may be mentioned.

The shipbuilder, in the preparation of his material for purposes of construction, requires nearly all the tools used in general engineering as well as some of special design. The question of the mechanical equipment of a shipyard is one of moment at the present day, where so much attention is being paid to labor-saving devices. The planning of a modern shipyard, with its numerous machine tools driven by electricity, compressed air, hydraulic power or steam; its machines for handling material, such as cranes, gantries, derricks, etc., makes it essential that the shipbuilders should have a thorough knowledge of mechanical engineering in all its branches.

The above discussion will give a general idea of the line of work that should be followed in the training of a marine engineer in its broad sense, and with these facts in mind the course of instruction at the University of Michigan has been laid out.

The usual course of study in the engineering department has within the last year been increased to four years and one summer session. Students wishing to take up the study of marine engineering may do so in two ways; firstly, as undergraduate work, and secondly as a post-graduate course; the latter being recommended wherever possible.

If taken up as an undergraduate course, at the end of which the degree of Bachelor of Science in Marine Engineering is given, the work in general is divided as follows: The first year is devoted to language, French and German, or Spanish, English, mathematics, drawing, chemistry, and shop practice; the second year to languages as before, mathematics, physics, drawing, shop practice, and elements of mechanical engineering.

In the first semester of the third year these studies are continued in advanced stages, with the exception of languages, since most students come to the University with a certain amount of advanced credit in these subjects.

In the second semester, besides the usual mechanical and civil engineering courses, the students take the preliminary work in naval architecture. The summer school is devoted to electrical engineering and machine design. The fourth year is devoted largely to naval architecture and marine engineering, with some courses in mechanical and civil engineering.

The work in detail for the various years is as follows:

FIRST YEAR.

First Semester.

French, German, or Spanish.
English.
Mathematics, Algebra, and Analytic Geometry.
Geometrical Drawing.
Chemistry.
Shop practice. Forging or woodwork.

Second Semester.

French, German, or Spanish.
Physics, Mechanics, Sound, and Light.
Mathematics, Analytic Geometry.
Drawing. Description Geometry.
Shop practice. Woodwork or forging.

SECOND YEAR.

First Semester.

French, German, or Spanish.
Physics, Heat, Electricity, and Magnetism.
Mathematics. Calculus.
Drawing.
Shop practice. Pattern-making.

Second Semester.

French, German, or Spanish.
English.
Mathematics, Calculus, and Mechanics.
Mechanical Engineering. Elements.
Shop practice. Machine shop.

THIRD YEAR.

First Semester.

Mathematics. Calculus and Mechanics.
Physics. Laboratory.
Mechanical Engineering. Mechanism, Boilers, and Engines.
Surveying.
Shop practice. Machine shop.

Second Semester.

Civil Engineering. Graphics and Strength and Resistance of Materials.
Mechanical Engineering. Mechanism and Machine Design. Thermodynamics.
Engineering Laboratory.

Naval Architecture. Structural Arrangements of Ships.
Architecture. Mould Loft Work.

FOURTH YEAR.

First Semester.

Civil Engineering. Hydraulics.
Mechanical Engineering Laboratory.
Naval Architecture.
Marine Engineering.
Ship and Engine Drawing.

Second Semester.

Mechanical Engineering, Laboratory and Special Work.
Naval Architecture.
Marine Engineering.
Ship and Engine Drawing and Design.
Thesis.

When arranged as a post-graduate course, the student completes the course in either mechanical, electrical, or civil engineering in the ordinary way, taking up the preliminary studies of naval architecture and marine engineering in his fourth year, and devoting the fifth year almost exclusively to these subjects.

Students from other colleges, or others who have had the necessary training, are also admitted to these courses as special students.

The work of the course is conducted in a series of lectures and recitations, practical demonstrations of various topics being given whenever possible. The preliminary courses are devoted to ship construction, in which the various types and parts of the structure are discussed, and the student required to hand in sketches of these each week. The practical part is devoted to mould loft work, and the student here is taught the routine of laying off a vessel and all connected therewith.

The theoretical work in the other courses is divided under the following heads: Calculations, Strength, Stability and Rolling, Resistance and Propulsion. Lectures are also given in

designing, preparation of specifications, and several special topics.

In the drawing class the student lays out and fairs a set of lines, and performs all such calculations as those of displacement, centers of buoyancy, metassties, trim, launching, flooding, capacities of holds, etc., upon the vessel he has drawn. Later a design is undertaken, which includes the preparation of lines, general arrangement plans, principal steel plans, all calculations connected with the above, including those relating to the strength and stability of the vessel. A general specification is also prepared. The drawing office is supplied with all the necessary instruments, such as planimeters, intigrators, batters and weights, etc., and the student also has access to a number of plans of various vessels and their machinery.

Where a student wishes to devote his attention especially to the engineering side of the subject, the general class work is approximately the same, but in the drawing courses a complete machinery installation instead of a vessel is designed; in either case, however, a general design of a boiler and engine is required.

In the marine engine and boiler design courses, the classroom work is given mainly by lectures, in which all the principal points connected with these are discussed, and illustrated throughout by frequent reference to actual working drawings. The principal aim of the course of instruction is to give the student a thorough grounding in the theoretical part of the subject. The practical side is, however, not neglected, and wherever possible the value of theoretical investigations as bearing upon practical work is emphasized. The drawing courses are designed so that the work covered shall be as practical in its nature as possible; but in these also theoretical investigations are not forgotten.

To help in the practical demonstration of various topics, the students are also taken to visit the different shipyards and engine works in the vicinity.

The development of the scientific treatment of problems relating to shipbuilding may be said to date from about 1860,— a little over forty years ago, although previous to that time many

topics had been investigated by mathematicians. The foundation of the institution of naval architects in London in 1860 marks the first attempt to collect those interested in shipbuilding and its associated professions into one body. Among those who were some of the earliest members were men whose names are known the whole world over, and whose memory will never be forgotten while the engineering profession lasts. The names to which special attention may be called are those of Scott Russel, Rankine, and Fonde, each of whom stand out prominently as the early investigators of the scientific problems relating to shipbuilding. Fronde was the first to carry out systematic experiments upon models in order to determine the resistance to motion of various forms, and by means of his well-known "law of comparison" to predict from the results of model experiments, the resistance of the full-sized vessel.

As the University of Michigan is about to be equipped with an experimental tank for a similar purpose, a short description of the same, and its value from a scientific and practical standpoint, may be of interest.

The tank is situated in the basement of the new building and extends along the east side of the north wing, projecting about one hundred feet beyond the engineering laboratory. It is 300 feet long, 22 feet wide, and 10 feet deep at the center. Along each side and running the whole length of the tank are brackets upon which are placed rails for carrying a truck hereafter described. The bottom of the bracket on each side is curved from the waterline upward, and will, it is anticipated, act as a damper for the waves formed during the experiments.

Upon the rails is mounted a truck which extends across the tank, in a similar manner to a traveling crane. This truck is driven by a motor, and is capable of variation of speed from something under fifty feet per minute to between seven and eight hundred feet per minute. Attached to this truck are two dynamometers, one of which registers the resistance of the ship and the other the various observations connected with the propeller. The model, which is from twelve to fourteen feet in length, is made to correspond with the lines of the vessel as drawn. The material that it is propsed to use for the models

is paraffin wax of about one and one-half inches thick. First a model is cast to a shape approximating to that required, and is afterwards placed in a cutting machine which consists of two revolving cutters so arranged that they are made to follow the motion of a tracer which is kept to any of the given lines on the drawing. In this manner the model is cut in a series of grooves, the bottom of which represent the corresponding line of the drawing; the remaining projecting pieces are then removed and the model faired by hand. In order to have a correct record of the model as actually tried, it is then taken to a testing table and the correct lines, or shape of the sections at different points recorded. The draught marks are then placed upon it and the model carefully weighed. In order to bring it to the various displacements required it is ballasted with shot bags, the weight of these being also carefully noted. By shifting these bags any desired trim for one displacement can be obtained.

The model is then attached to the spring on the dynamometer, and when towed the varying resistance at the different speeds is measured by the extension of the spring, which extension is recorded upon a drum in the ordinary way. The model propellers are cast in plaster of paris molds much in the same way as the full-sized ones, and are afterwards carefully tested in a lathe and brought to the required shape and dimensions. They are then mounted upon a framework astern of the vessel and driven by means of a gut drive, through a dynamometer which registers the amount of turning force required to drive them. The thrust is also measured in a similar manner, and the revolutions also recorded. If the speed of the truck be kept constant and the propeller driven at a varying number of revolutions, the thrust will increase with the revolutions, and a point will eventually be reached where the thrust of the propeller is equal to the resistance of the ship. When this happens, the case of the propeller driving the ship is reproduced — subject to certain corrections which need not be entered into here. Owing to the position of the propeller and its method of operation the resistance of the vessel is materially altered as compared with that of the vessel alone; and the presence of the vessel in front

of the propeller affects the performance of the latter as compared with the case of the propeller alone. There is, therefore, as will be seen, a large field for investigation in these considerations, namely, the best form of vessel for any given set of conditions, and the best form of propeller for that vessel. It is also proposed later on to fit a movable false bottom in the tank so that the effect of depth of water upon resistance of various types of vessels may be investigated.

In order to pass from the model to the full-sized vessel and propeller recourse is had to Fronde's Law of Comparison, which is as follows: At corresponding speeds, that is, speeds which are proportional to the square root of the linear dimensions, the resistances will vary as the cube of the dimensions. As an example, let the model be 12 feet in length and the full-sized vessel 432 feet. At a speed of say 300 feet per minute the model has a resistance of say 4 lbs. The corresponding speed of the full-sized vessel will be, 300 x 432-12, 1800 feet per minute, or say 18 knots, and the resistance of the full-sized ship 4 x 36, 186,624 lbs.

Model propellers also follow somewhat similar rules, which are, however, a little more complicated and need not be mentioned here.

Many other investigations, such as those on rolling, and the action of bilge keels will also be carried out.

It is hoped that the tank will be completed in the course of the year, and that the shipbuilders of the country will not hesitate to make use of it whenever they so desire.
the year, and that when they so desire it the shipbuilders of the country will not hesitate to make use of it whenever they so desire.

The value of this tank from an experimental and instructional point of view is unquestioned; there remains, however the practical side which sooner or later must appeal to all. A small illustration may suffice to demonstrate this point. Cases have come under the writer's observation where the power required to drive two ships of the same size and displacement and under the same conditions, varied as much as from ten to twelve per cent. If then by experimenting on changes of form of ves-

sel and propeller we can obtain a vessel that requires ten per cent less power than another, there will be a saving of first cost, depreciation and coal, of approximately this amount. In the case of a large Atlantic liner of say 30,000 I. H. P. the saving would be 3000 I. H. P., or say about $100,000 in first cost, and a saving in coal per voyage of about $1,000.

CONCRETE — STEEL CONSTRUCTION.

(As Applied to Sewers and Conduits.)

GEO. S. PIERSON,

Consulting Engineer, Kalamazoo, Michigan.

Through the city of Kalamazoo flows a stream called Arcadia Creek. This stream drains an area of about 3,750 acres. The basin of which this stream is the natural drainage is about five miles in length, east and west, and about two and one-half miles in width, north and south, in its greatest dimensions. About 3,000 acres lie outside of the city limits, and about 750 acres lie within the city limits. The length of the stream within the city boundaries is about 12,600 feet.

Within the city limits the area which drains into the stream is comparatively narrow, being, in the business portion of the city, only about 2500 feet in width. Farther up the valley the drainage area widens out into a pear-shaped form.

This stream is fed by living springs. At all seasons of the year there is a considerable flow in it and at times a large flood discharge.

The average fall of the stream within the city limits is about four-tenths per hundred. In early days there were two or three small water powers on this stream which have been purchased by the city and the dams removed. In the upper portion of the valley the greater portion of the area is rather sandy, so that, under ordinary conditions, a relatively small percentage of the rain-fall is immediately discharged into the stream.

In the eastern portion of the valley, and adjoining the city, the ground is rolling, fertile, much less porous, and slopes more rapidly toward the stream.

Up to the commencement of the work described in this article, no systematic improvement or even protection of the chan-

nel of Arcadia Creek, in the business portion of the city, was attempted. Numerous bridges and culverts have been built over it, which varied greatly in size and form, and were placed without reference to any proper gradient of the stream. In some instances, piles had been driven into it to support buildings; building foundations had encroached upon it; railroad culverts of too small capacity had been built, and the sides of the channel had been lined with planking which restricted its flow to such a degree that, during floods, the basements of buildings were flooded and serious damage done.

As pavement areas have been extended in the city, and storm sewers which discharge into the stream have been extended from year to year, these conditions have been aggravated. During the last twenty-five years numerous attempts have been made by parties interested to bring about some improvement in the channel. These resulted in no concerted action until in the spring of 1902, when a bond issue was authorized by general vote, to improve that portion of the channel below Burdick street, and the work was put in charge of commissioners appointed for that purpose.

Burdick Street lies in about the center of the business portion of the city, and the distance from this point to where the stream discharges into the Kalamazoo River is about 3,764 feet.

This portion of the stream runs under many business blocks, crosses seven streets and twelve railroad-tracks and side-tracks. The city has a system of sewers, and the main sewers lie at a lower level than the stream, and crosses under it in several places. Many of the foundations of buildings along the stream do not extend below the level of its bed, and the same may be said of the foundations of bridges which span it. In some places, therefore, no radical change in the elevation of the bed of the stream could well be made, and it was not feasible to lower the bed of the stream to a degree which would otherwise have been advisable. A limit was in like manner set upon the depth of a new channel by street grades, yard areas, and the floors of buildings which had long been established, and to which the surface must closely conform.

It was a difficult matter in this instance, as it is in many others, to forecast the maximum flow to be provided for in the new channel. A survey of the entire water-shed was made, and also a detailed survey of the entire channel within the city limits. The cross section of the stream at all points where there were culverts, buildings, tunnels, and other permanent construction was measured. The depth of the foundation footings was measured, and a profile of the stream was made on which was platted these various cross sections in their true position.

All the information obtainable in regard to flood elevations was marked on this profile, and a rough approximation to the greatest discharge up to this time was made. Shortly after the project was started, there occurred two rather severe floods,

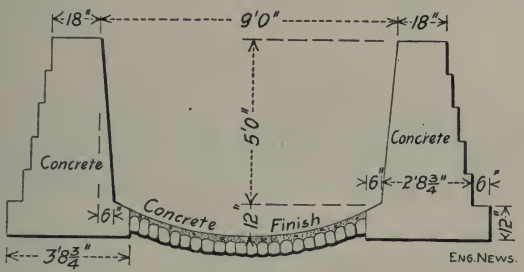


FIG. 1. CROSS SECTION OF OPEN CHANNEL FOR STREAM DIVERSION AT KALAMAZOO, MICHIGAN.

though not as severe as have been known at other times. During these floods of 1902, a record was kept of the stage of the water at numerous points along the stream, and the maximum height to which the flood rose was platted upon the profile. This information was important, and assisted in forming a conclusion as to the probable maximum discharge which should be provided for. Computations were also made of the probable future discharge of areas within the city limits, and from this and other information of like character the size of the proposed channel was fixed. The position of the bottom of the channel was determined from the depth of footings of the more substantial buildings along the route. Less important footings were replaced or strengthened where it was desirable to lower the grade at these points.

The conditions in the business portions of the city did not allow an arched construction owing to the lack of head-room and cover. There were also numerous places along the channel where the side walls were substantially built and where the area of section was sufficient. These it was desired to retain, and as they occurred at frequent intervals, no continuity of construction would have been possible if an arched section had been adopted.

The cross section shown in Figure 1 was adopted for this portion of the work. The footings were placed as low as the adjoining foundations permitted, and the flow-line still farther lowered by an inverted arch placed between the side walls, as shown in the figure. At some places where the walls already in place did not afford sufficient capacity, one of the old walls was retained and faced with concrete, and the opposite wall

FIG. 2. I-BEAM AND REINFORCED CONCRETE CONSTRUCTION TO CARRY STREETS OVER OPEN CHANNEL.

was removed and replaced by a new one, the alignment of the channel being rectified as much as possible. In some places it was necessary to remove the entire foundations of heavy buildings and to replace them by one of the sidewalls.

All of the sidewalls were built of concrete composed of sand, gravel, and Portland cement. It was necessary to do this work without interrupting the flow of the stream and it was diverted alternately to one side and the other of the channel. The inverted arch is laid of cobble-stones taken from old cobble gutters near at hand, and laid in Portland cement.

At street crossings, steel I-beams were laid upon the sidewalls. Woven steel wires were placed across the I-beams, as shown in Figure 2, a platform was supported beneath the whole, and concrete was tamped about and over the I-beams to carry the traffic. The surface of this concrete is about five inches be-

low the established grade of the street so that the surface of the pavement will be continuous over the bridge.

At a point about 1,500 feet from the old outlet of the stream, the natural channel makes a detour toward the north, and cuts through many of the city lots in such a way as to materially diminish their value. From this point, an alley extends directly east toward the river, and by purchase of a short right of way over private property, it was possible to shorten the length of channel about 700 feet and to improve the conditions in this part of the city very much. This route was therefore adopted for the new construction.

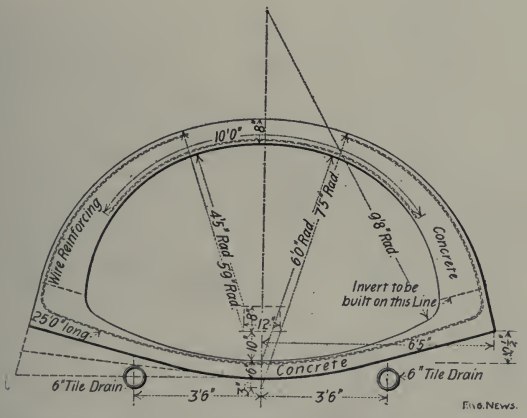


FIG. 3. CROSS-SECTION OF REINFORCED CONCRETE CULVERT FOR STREAM DIVERSION AT KALAMAZOO, MICHIGAN.

In this portion of the work there was sufficient head-room for an arched cross-section. In fact, a covered construction was necessary in order to preserve the utility of the alley and in order to secure the private right-of-way at a reasonable figure. This portion of the new channel was constructed as shown in Figure 3, and it is this part of the work to which this article more particularly refers. The work was done entirely by day labor, under the direction of the commissioners, and under the charge of a competent foreman experienced in the handling of concrete. It is 1,080 feet long, was commenced November 3, 1902, and finished January 10, 1903.

The form of cross-section is shown in the figure. The dimensions are nine feet and ten inches in the clear, horizontally, and six feet in the clear, vertically. The grade varies from .4 to .5 in 100.

Most of the excavating was done by wheeled scrapers. The masonry is entirely of concrete composed of sand, gravel, and Portland cement. The proportions are generally about one part of Portland cement to six parts of sand and gravel. The

FIG. 4. VIEW SHOWING INVERT CONSTRUCTION OF REINFORCED CONCRETE CULVERT.

upper arch, however, was made of a somewhat richer concrete than this, and the lower arch with a somewhat poorer concrete. These proportions were not rigidly adhered to, the composition being generally made richer under street crossings, where there is a light covering of earth, and also where particularly treacherous soil underlaid the foundations.

The section is re-inforced by a woven-steel wire fabric, shown in the cross-section. The members of this fabric that

extend around the sewer are of No. 11 steel wire, and two layers of the fabric are used in all cases, thus making a total length of wire surrounding the sewer of seventy feet. There is an average of about five wires per lineal foot enclosing the conduit, except where the outer and inner re-inforcements overlap; in this case there is double this number.

The bearing portion of the concrete in the inverted arch was changed in form, as shown by the dotted lines, according

FIG. 5. END VIEW OF REINFORCED CONCRETE CULVERT, SHOWING CENTER IN POSITION.

to the character of the earth on which the concrete was to be laid. In some parts of the work the conduit rests on rather soft material. For a considerable portion of the way it rests upon quicksand. In ground of this character, two lines of tile drains are laid under the invert of the sewer, and these, by removing the excessive water from the quicksand, made it firm and a good foundation.

Figure 4 is a photograph taken during construction in this material. The lower portion of the invert of the conduit was

brought to a true form by means of a straight-edge sliding on transverse templates, shown in place in the photograph. At the sides, the concrete was packed in behind forms which are held in place by transverse hinged struts, also shown in the photograph. At this height the concrete was brought to a slightly inclined surface so as to properly receive the thrust of the upper arch, and was roughened so as to make a proper bond with it. The re-inforcing metal laid in the invert is in one continuous piece, extending up nearly to the crown of the arch, as

FIG. 6. VIEW SHOWING REINFORCED ARCH UNDER CONSTRUCTION.

shown in Figure 3. In the photographs the part of this metal which is to be imbedded in the upper arch is plainly to be seen.

Figure 5 is from a photograph, showing a section of the upper arch with the centering and templates on which it was built still in place.

In building the upper arch, the concrete was well rammed against substantial, tightly boarded centers, which rested upon the invert form, and was also supported at the crown by struts resting upon plank lying along the invert. Planks were placed

longitudinally on the exterior of the arch along its lower portion, to confine the concrete to the proper form, and to hold it in position so that it could be thoroughly compacted. Nearer the crown of the arch no such outside form was used.

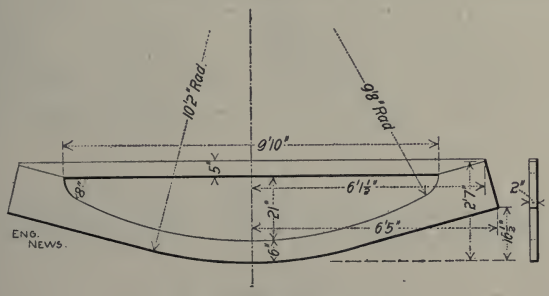


FIG. 7. INVERT TEMPLATE.

The exterior of the upper arch was brought to the proper form by a straight-edge sliding along transverse templates.

Figure 6 is from a photograph of the upper arch during construction, and shows the templates and wire netting. In the same Figure can be seen a portable bridge, which was moved along as the work progressed.

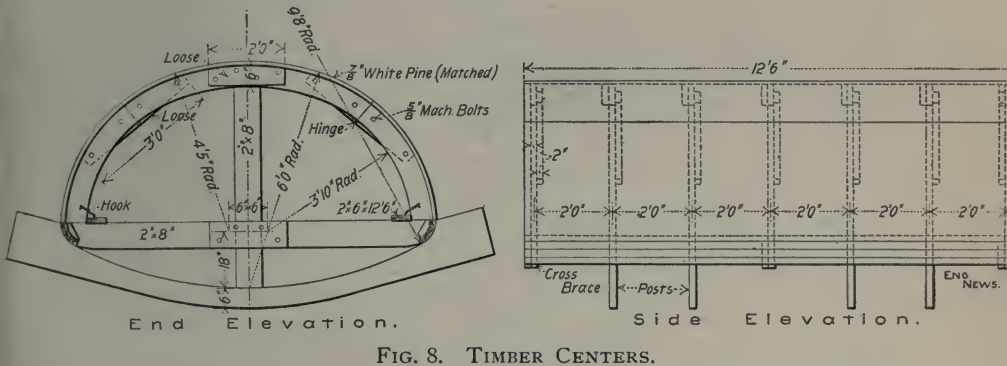


FIG. 8. TIMBER CENTERS.

The centers were built in sections twelve and one-half feet long, Fig. 8, and a sufficient number was provided to lay twelve sections of invert and six sections of arch. The templates and centering are all arranged so they can readily be taken down

without any jarring of the concrete. The upper forms are hinged at the quarters, can be separated in two pieces and folded together, so that those farthest back in the conduit, where the concrete has had more time to set, can be brought forward through those which have been set in more recent construction, and where the concrete is still fresh. All of the centering is loosened by unbolting a piece which spans the hinged joint in the center of the struts, and then moving the center of the struts latererally. Fig. 10.

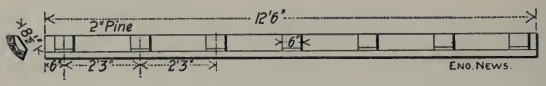


Fig. 9. Side Forms.

In work of this kind it is very important to have the centering absolutely rigid so that it will not spring when concrete is being tamped against it, and thus weaken the cohesion of the concrete. It is also important to have the arrangement such that all the centering can be removed without straining or jarring the fresh concrete. The centers were generally removed in about three or four days after the concrete arch was

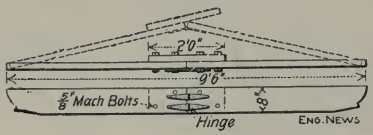


Fig. 10. Hinged Struts.

in place. Before backfilling about the arch, its exterior was well brushed with neat Portland cement mixed with water. The interior of the conduit was also finished in the same way.

Much of the work of construction was done when the thermometer, during working hours, ranged from twelve to twenty-five degrees above zero. When the temperature was below freezing, hot water was used in mixing the concrete, and on a few of the coldest days, salt was dissolved in the water. The work was never discontinued on account of cold, but was discontinued during several storms of sleet. In cold or stormy

weather each section of concrete was covered with oiled canvas as soon as completed, and the conduit was kept closed at each end, so far as practicable, in order to retain the heat.

At two points it was necessary to depress the water mains, and at one point an inverted syphon was required in a main sewer. Where the conduit crossed under railroads, the section was modified by carrying the sidewalls up vertically and supporting the traffic upon heavy iron I-beams.

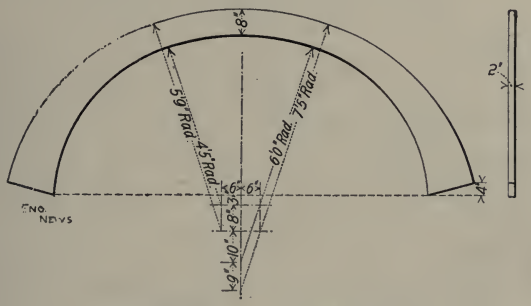


FIG. 11. ARCH TEMPLATE.

This conduit is intended to remove only the storm-water which naturally flows from the valley and the discharge of surface water from the streets. The sewage proper of the city is provided for in other channels, and its discharge into this conduit is not allowed.

The following table was compiled from accounts kept during the progress of the work:

Excavation commenced October 23, 1902.
Concrete work commenced November 3, 1902.
Concrete work completed January 3, 1902.
Average progress per day.....18.6 feet.
Greatest number of feet laid in any one day.....28.
Average number of laborers per day, mixing and wheeling 10.04
Average number of laborers per day, placing concrete 5.
Average number of laborers per day, setting up form 4.57

Cu. yds. of concrete mixed and wheeled per day, per man	1.96
Cu. yds. of concrete placed per day, per man	3.54
Cu. yds. of concrete per lineal foot	.95
Barrels of cement per lineal foot	1.18
Barrels of cement per cubic yard	1.24
Proportion of cement to sand and gravel	1-6

COST PER LINEAL FOOT.

Sand and gravel	$ .42
Cement	2.44
Mixing and wheeling concrete	.98
Labor, placing concrete	.47
Forms and templates	.30
Metal fabric	.39
Setting up forms	.43
Finishing	.09
Tools, general expenses, and superintendence	.43
Total cost of masonry per lineal foot	$5.95

The above schedule shows the actual cost of the masonry in place, and includes the cost of all the work except the rough excavation, which is omitted for the reason that it often varies widely, has no general application, and is of less interest.

The cost of superintendence, tools, etc., is included, but the cost of engineering and general administrative expenses are not included.

Combinations of concrete and steel are rapidly growing in favor for various kinds of construction both here and abroad. In certain lines of construction the details have been the subject of extended study and experiment, and the general arrangement follows well-established principles. It is believed that this form of construction may often be used with great advantage in sewers and conduits, and it seems probable that its use in structures of this kind will be materially extended

in the immediate future. Up to the present time, however, the details of this class of work have not received as much attention as in the case of beams, floors, and similar work. In work of this class the stresses can be readily computed, and the construction can readily be tested in an experimental way. In the case of a sewer, it is difficult to compute the stresses to which the shell may be subjected, and difficult to subject a section experimentally to the strains which occur in practice. This subject, therefore, opens up an interesting field for investigation.

HASLETT PARK SINK-HOLE ON THE GRAND TRUNK RAILWAY.

LESLIE A. WATERBURY,
INSTRUCTOR IN MATHEMATICS AND CIVIL ENGINEERING,
MICHIGAN AGRICULTURAL COLLEGE.

The Grand Trunk Railway has experienced considerable difficulty in many places in Michigan, with sink-holes. One of these is located between Haslett Park and Lansing, near mile-post 107.

These sink-holes are caused by small lakes which are covered with a layer of peat bog, so as to present an appearance of ordinary marsh land. The formation of such bogs is described by N. S. Shaler, in the Tenth Annual Report of the United States Geological Survey. The diagram illustrating this

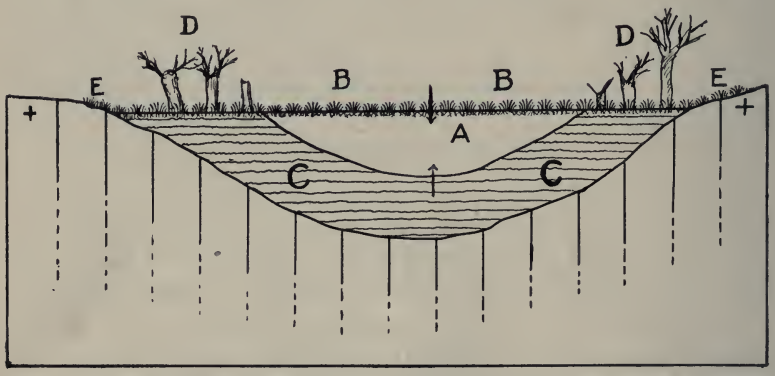


FIG. 1. (From N. S. Shaler's Report, Tenth Annual Report U. S. Geological Survey.) SHOWING FORMATION OF PEAT BOG.

is also taken from the same report. The formation of the crust BB is caused by a growth of water-moss, which requires no under soil for its roots to penetrate, the species of sphagnum being the most prominent of this class of plants. The growth begins near the shore, and gradually extends over the surface, until the entire pond has become covered with a dense mat, which increases in thickness, collecting soil washed down

from the surrounding hills, thus affording opportunity for other vegetable growths, and in this way a considerable crust is formed. In the diagram, A represents the remaining portion of the water area; CC represents muck, or a peaty mass derived from the disintegration of the surface layer; DD shows the solid part of the swamp, bearing trees near the shore, and further out bushes; EE indicates climbing bog, which may be absent; + + shows the original water-level, and the arrows indicate the direction of growth of the upper and under layers of peat.

In the case of the sink-hole near Haslett Park, the pond has a crust about six feet thick. The upper portion of the crust is quite firm and solid, but gets softer beneath, so that the bottom, which is in contact with the water, is soft and spongy. Upon this crust there is a considerable growth of trees and bushes. Some of the trees are of very good size, yet their roots do not penetrate much below the surface, but spread out in the upper portion of the peat crust. As would be expected, from the character of its formation, the crust covering the lake is light, and is composed largely of organic matter. Three air-dried samples analyzed at the Agricultural College were found to be composed of the following ingredients:—

SAMPLE NO. 1.

Taken south of hole and one foot from surface.

Moisture	8.92 per cent
Organic matter	79.06 per cent
Mineral matter	12.007 per cent
Total	99.987 per cent

SAMPLE NO. 2.

Taken 100 feet south of hole in crust, from ground exposed by a tree which had been blown over.

Moisture	10. per cent
Organic matter	80. per cent
Mineral matter	10. per cent
Total	100 per cent

SAMPLE NO. 3.

Taken from water at north side of hole.

Moisture	10.57	per cent
Organic matter	83.74	per cent
Mineral matter	5.691	per cent
Total	100.001	per cent

The specific gravity of this crust is very nearly 1. Pieces of it which were placed in water in a frozen condition floated, but generally sank after thawing. However, the material as it is around the sink-hole has a considerable supporting power. This is perhaps due to the fact that marsh gas is generated by the decomposition, and also to the fact that the crust would withstand tension so that any load coming upon the surface would not depend entirely upon the floating power of the crust beneath for its support .

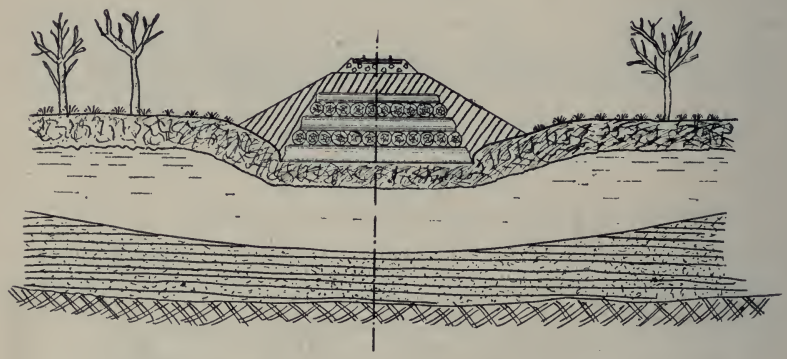


FIG. 2. CROSS SECTION SHOWING ORIGINAL CONSTRUCTION OVER PEAT BOG.

It was upon this bog that the road was originally built. To add to the supporting power of the crust, a large quantity of timber was first laid upon the surface, forming a corduroy foundation some twenty feet deep. Upon this foundation the embankment and the track were placed. The construction is shown in the diagram.

After the construction of the road, little difficulty was experienced at this point until preparations were begun for laying double track. At this time, the dirt, which was dumped beside the old track for the purpose of widening the embankment, gradually sank out of sight, leaving a pond of water, at the same time forcing the crust apart and pushing the track and right-of-way fences out of line. The plan of the sink-hole

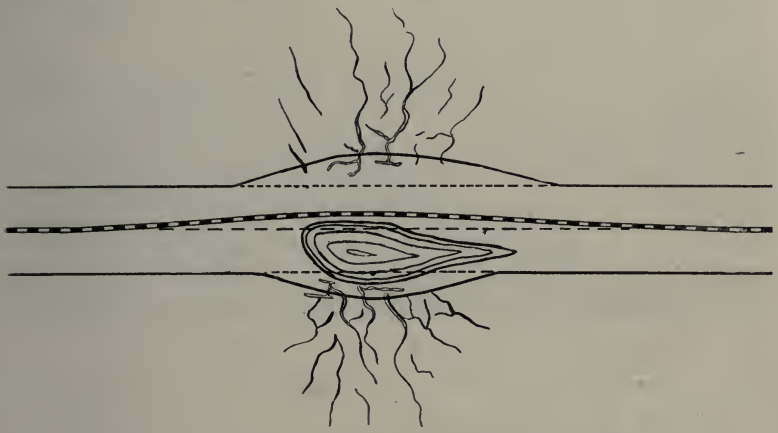


FIG. 3. PLAN OF SINK-HOLE SHOWING DISTORTION IN ALIGNMENT, AND CRACKS AT SIDES.

shows the alignment of the track, and approximately that of the fences as it was Nov. 26, 1902. The track had been further out of line than the diagram shows, but had been thrown back before the displacement was measured. The broken lines show the original positions of track and fences, and the full lines show them after being distorted. The portion of the track which had been moved the most was 19 1-2 feet from its original position when measured. The portion of the fence which had been displaced most was 38 feet from its original position.

The material used for widening the embankment was till, a mixture of sand and clay, and was much heavier than the peat crust. This filling carried down with it not only the crust beside the track, but also the embankment upon which the track rested. It also broke the crust so that the track sank under the action of traffic. Whenever a train passed the track

would sink four or five tenths of a foot, and would then have to be jacked up and filled in beneath before traffic could be resumed. Cinders were used for the filling directly under the track on account of lightness, while the filling at the side was continued with till.

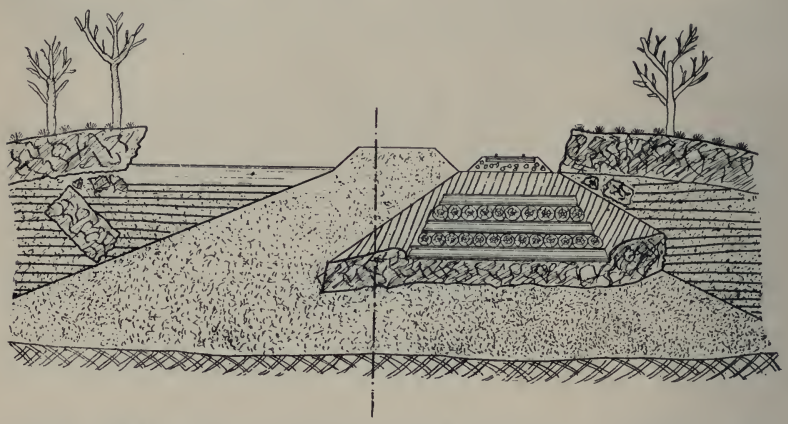


FIG. 4. CROSS SECTION SHOWING DISPLACEMENT OF ORIGINAL EMBANKMENT, AND DISPLACEMENT OF MUCK BY FILLING, CAUSING CRUST AT THE SIDES TO BE RAISED.

The sinking of the track caused the peat layer beneath to break away from that adjacent on each side. Then the filling of the heavy material, together with the consequent displacement of the muck beneath, caused the peat crust on each side to be floated upward. The amount of vertical lift near the right-of-way lines was at least six feet. Thus a cone was formed with a radius of from 250 to 300 feet. The lifting of the crust developed cracks from one to two feet wide near the track, and radiating from the center to the base of the cone, somewhat as shown in the plan.

A section of the hole along the track is shown on the profile, which is taken from the company's profile. The bottom was determined by soundings. The profile shows the hole to be about 28 feet deep.

The portion of pond over which the crust first broke extends from about station 120 to station 124. Into this opening

30,000 cu. yds. of material was placed before the track stopped sinking. Between stations 115 and 120 the embankment was widened upon the top of the crust, as it was thought there would be sufficient support at that point. Since that time this section has also gone down, and has required 10,000 cu. yds. of material to form an embankment of sufficient width for

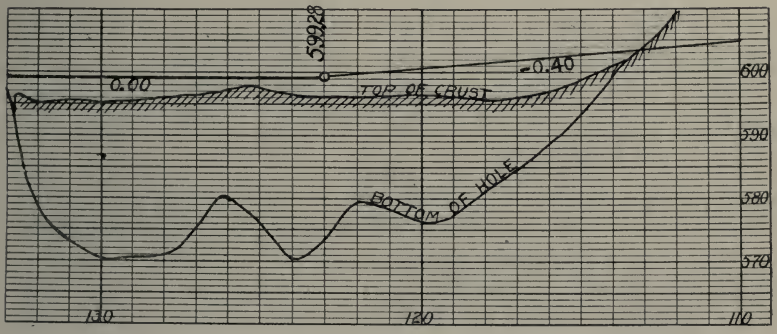


FIG. 5. PROFILE SHOWING SECTION OF SINK-HOLE ALONG LINE OF TRACK.

double track. This filling has raised the crust on one side of the track, but not on the other. Over the remaining portion of the pond between stations 124 and 133 the embankment has been widened to its full width upon the peat crust, but it is the intention of the company to fill the hole beneath this next spring.

Filling placed in water assumes a flat side slope, but in this case it does not seem probable that it can be as flat as the slope of the cone, since the cone extends from 250 to 300 feet on each side. If this cone which has been displaced were filled with till it would require from 14,000 to 15,000 cu. yds.; or, since the total amount which had been placed in the hole at that time was 30,000 cu. yds., about one-half of the total filling. The distance of the base of the cone from the bottom of the pond would be about 20 feet, so that it would be impossible to fill the hole in this manner with 30,000 cu. yds. It is therefore probable that there is quite a quantity of muck or semi-fluid material near the bottom of the lake caused by the disinte-

gration of the peat crust. This muck has been displaced by the heavier filling, and has been forced out on each side so as to lift the crust. The probable cross-section after this has occurred is shown in FIG. 4. The diagram also shows about the amount which the track was displaced,

There are many other sink-holes in the vicinity of the one described, there being at least eight such formations within a distance of six miles. The largest of these is 55 feet deep, and has already received over 60,000 cu. yds. of filling. It is the intention of the company to break the crust above these holes, a little at a time, and to continue the filling until the track shall have a solid foundation.

If coarser material, such as rock or coarse gravel, were obtainable for filling, or if the present material should be placed in bags, a much smaller amount would be required, since it would not be floated out like till, which is in a finely divided state. However, under the present conditions the method used is probably the most economical.

For information and assistance in the preparation of this paper, the writer is indebted to Mr. A. C. Lane. State Geologist; Mr. Jos. Hobson, Chief Engineer Grand Trunk Railway; Mr. H. A. Woods, Engineer in Charge; Mr. C. C. Hill, Resident Engineer, and others.

NOTE.— This paper was very fully discussed, as were others, at the convention, but through unfortunate circumstances it has been impossible to secure a satisfactory report of the discussions. SECRETARY.

THE BEST FORM OF RAIL FOR STREET RAILWAYS.

E. W. MUENSCHER,

Member American Society Civil Engineers.

The rapid growth of the electric street railway in the United States has made the problem of the best form of construction, especially on paved streets, one of supreme importance, both to the public and to engineers of all classes, especially municipal and electrical. The conflicting interests involved, and the diverse points of view from which this problem has been met, have led to wide differences of opinion, and even to bitter controversy.

There are really two distinct problems involved: 1st, the best form of rail; 2nd, the best construction for the foundation and connection with the pavement. The latter problem is beyond the scope of this paper, and, in order to place the discussion of the former on a fair basis, we will assume that in all cases that form of construction is adopted which is finally determined by experience to be the best for all interests concerned.

The sections of rail in use in this country on street railways may be counted by the score. In one system alone, that of Providence, R. I., no less than 27 different sections are said to be in use, not including special work. This variety of sections is doubtless due to the flimsy construction of the old horse-railways on which electric cars were first used, and the efforts of independent designers to remedy the evils which were speedily developed by these cars. This construction is fast disappearing, and the rails now in use are nearly all of some form of girder rail, and from five to nine inches in depth.

These girder rails may be divided into four classes: 1st, the T rail; 2nd, the full-grooved; 3rd, the half-grooved; 4th, the tram rail. Of these forms the four sections of the Pennsylvania Steel Company may be regarded as typical. A considerably different section is the standard of the Metropolitan Railway Company of New York, and is there known as the Trilby rail.

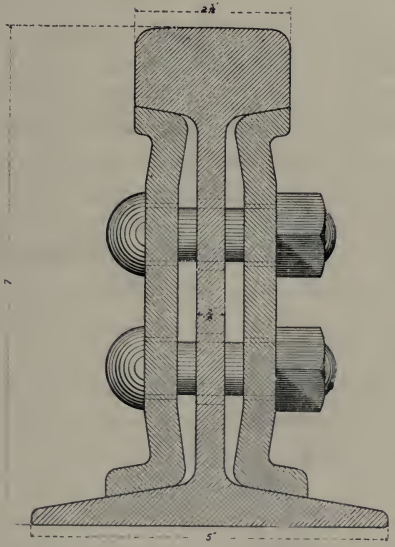
Each of the sections above mentioned has its warm advocates and its bitter opponents, and the question of a choice between them should be approached in a spirit of fairness and disinterestedness, especially by municipal engineers, upon whom, owing to the lack of knowledge of the merits and demerits of the different sections on the part of the authorities of most small cities, the choice often devolves. Too often it is approached in a hostile spirit, the public looking upon the railway company as a grasping monopoly to be antagonized at every point, and the municipal engineer feeling that he must share the prejudices of his employers, and failing to appreciate the fact that the two interests are always inextricably intertwined, and that in many cases, especially in small cities, the public receive the full benefit of a street railway system from the outset, while the company may for years be operating it without profit, or even at a loss.

In the choice of a rail four distinct interests must be considered: 1st, the railway company; 2nd, the taxpayers and their representatives, the city authorities; 3rd, the users of wheeled vehicles; 4th, the traveling public, who use the cars for transit.

The railway company desires a rail which will be the cheapest in first cost and cost of maintenance; the most durable; and the one most easily kept clean and offering the least possible resistance to the traction of the car or the free flow of the electric current. The taxpayers desire a rail which will cause the least possible cost of construction and maintenance of pavements. The owners of light vehicles desire a smooth, unbroken surface which they can traverse in every direction without jolt or danger. The drivers of heavy drays or transfer wagons desire either such an unbroken surface or a rail which their wheels can readily follow and easily leave. The traveling public care nothing about the form of the rail, provided it gives them regular, quick, safe, and comfortable transit from point to point. It is plain at first sight that these requirements are radically inconsistent with each other, and that any choice of a rail must be a compromise between them.

An unbroken surface of pavement is impracticable. The electric cars cannot keep on the track without flanges on the

wheels to guide them. To provide for these flanges either the tread of the rail must be raised to a sufficient height above the pavement, or there must be a depression or groove of sufficient depth to receive them along each rail. The former construction, once in use with the old center-bearing rail, proved to be such an intolerable nuisance that no city will now permit its use, and a groove of some kind becomes a necessity. The best form and material of this groove is practically the problem to be solved. Let us study the fitness of the several forms of rail to meet this problem.



HIGH T OR "SHANGHAI" RAIL.

The T rail is the section in universal use on the 200,000 miles of steam railways in this country, on all the suburban and interurban roads, and many of the street railways. It is the development of more than half a century of experience, and its defects have been gradually eliminated until its present form leaves little, if anything, to be desired. There are numerous sections in use embodying the ideas of different engineers, but these are being rapidly superseded by those recommended by the American Society of Civil Engineers, which promise to

eventually become universal. The heavier sections have developed some defects, but it is believed that these will be remedied through the studies of the very able committee of that society which has the matter in hand.

The merits of the T rail are such that no steam or interurban railway would think of using any other, and no street railway would use any other unless compelled to do so. These merits are: 1st, for a given weight of metal it is the strongest form of girder. In the recent sections every ounce of material is placed where it will do the most good. 2nd, for a given weight it is the stiffest form of girder. This is a matter of great importance, for the stiffer the rail the less likely it is to break up the adjacent pavement by its vibrations under the passage of the car. Other forms may be equally stiff but with greater weight. 3rd, It can be kept clean more easily than any other form of girder, and therefore offers less resistance to traction and to the free flow of the electric current from the wheel to the rail, a feature of the utmost importance on roads operated by electric power. 4th, it offers no attraction to street traffic. It is so difficult to keep a wheel on the narrow head that it is seldom attempted, and thus the delays occasioned by trucks traveling ahead of the cars, and the consequent injury to pavements, are avoided. 5th, it is the cheapest form of girder rail for several reasons. Its symmetrical section makes it easier to roll than any other form, and for this reason it is often sold at a less price per ton than other forms of the same weight. There being no superfluous metal, as in the lip or flange of other girders, it has less weight than any other form of the same strength. The 7-inch T rail of the Pennsylvania Steel Company, with a 5-inch base and a ⅜-inch web, weighs 70 pounds per yard. The Tram rail, of the same base, height and thickness of web, weighs 80 pounds, the full-grooved rail 83 pounds, and the half-grooved 72 pounds but with only 4-inch base and 5-16-inch web, and consequently less stability. A mile of straight, plain track would require 110 tons of T rail, 125.71 tons of tram-rail and 130.43 tons of the full-grooved. Even at the same price per ton for all sections, say $35 per ton at the mill, the T rail would cost $549.85 less per

mile than the tram, and $715.07 less than the full-grooved, a sum which would go far toward paying the cost of the most solid substructure of broken stone or concrete. To this must be added the freight on 15.71 or 20.43 tons of extra weight, the extra cost of handling from two to four times, which is proportional to the weight (about 14 per cent in case of the tram or 18 per cent in that of the full-grooved), and the additional cost of laying, which is considerable. Men familiar with laying the T rail can be found in almost every village, while those familiar with other forms of girder are comparatively scarce, and likely to be higher priced. The symmetrical section makes the fitting of the splices and bolts easier; it can be sprung in easily for curves of moderate curvature, or bent for sharper ones with the jim-crow or other portable rail-bender, while with other forms of girder this process is much more difficult, and in many cases can only be performed at the shop. Much of this extra expense is, however, offset by the cost of the extra bolts which may be required at each joint of the high T rail.

Mr. G. B. Francis, Chief Engineer of the Union Railway of Providence, R. I., in a paper before the Boston Society of Civil Engineers, says: "It probably costs three or four times as much for the grooved rail construction as for the high T." Also "The cost of the rolled steel 9-inch (grooved) will approximate $43 or $44 per ton; with the high T it is perhaps nearer $28."

6th, the T rail is the most durable form of girder for several reasons, which can better be noted later. This is a matter of great importance to the public as well as the company, for when a rail is worn out it must be torn out, and the adjacent pavement with it.

With all these merits of the T rail it is plain enough why the street railway companies all prefer it, and why they should be permitted to use it unless there are serious objections from other points of view. The only ones which the writer has ever seen urged are the obstruction which it is thought to offer to street traffic, and the difficulty of making a proper connection between it and modern improved pavements. These objections apply, evidently, only to the inside of the rail. The outer sides of all girders are so nearly alike that the same construction may

be used with all, and no one possesses any material advantage over the others. On the inner side of the T rail the flangeway is now formed either by paving bricks or granite blocks set at the proper distance from the head of the rail, and the intervening space filled to the desired height partly with cement grout and partly with an asphaltic composition which easily takes the required form; or, more recently, in a number of cities such as Milwaukee, Minneapolis, St. Paul, Scranton, Dayton, and others, by granite blocks cut, or paving bricks molded to the desired shape, and set close up against the web of the rail. The groove thus formed may be of any size and shape that may be desired.

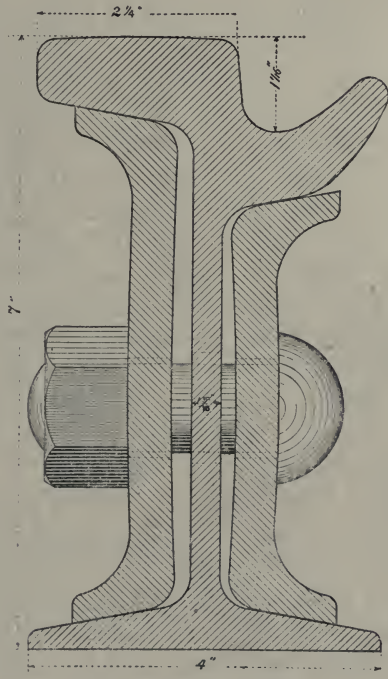
The Battle of the Rails, as already stated, turns practically upon what the size, shape, and material of this groove shall be.

Let us now pass to the opposite extreme of the list of girders, the full-grooved rail. In this rail the top of the lip, which forms the inside of the groove, is on the same level as the head, the groove is very narrow, usually 1-inch to 1 1-8-inch wide, and of about the same depth, and the sides are nearly or quite vertical. The flanges of street-car wheels are usually 1-inch thick at the base and 5-8-inch to 1-inch deep, usually 3-4 inch, and it is the custom to set the wheels on the axles to a gauge about 1-4-inch less than that of the track to give a little play. It will be seen, therefore, that this size of groove is the least that will admit the flanges, and that a 1-inch groove allows but little or no play to the wheels.

So far as the street surface and the interests of the owners of wheeled vehicles are alone concerned, it is fair to admit that at present, at least, this form of rail is probably the best that has been devised. It offers but little, if any, more inducement to wheeled vehicles to follow it than the T rail; carriages can cross it freely in any direction; the pavement can be laid close up to it on both sides; the lip and tread being of the same height, it offers the least possible break in the continuity of the pavement, and the groove is so narrow that very few wheels can possibly get into it. The tires of light carriages are usually about 1 1-4 inches wide, those of delivery wagons about 1 1-2 inches, and those of drays, trucks, and heavy wagons still wider, so

that none but abnormally narrow tires can get in. These features naturally make this rail a favorite with the authorities of many cities in this country, and in Europe it is said to be almost universally used.

On the other hand there are objections to this rail so serious that street railway companies universally and strenuously object to being compelled to use it, and for several substantial reasons



HALF-GROOVED RAIL.

1st. It is the most expensive form of rail, as we have already seen. 2nd. It is not durable. 1st. Because the tread being from motives of economy usually made only about 2 1-8 inches wide, while that of the T rail is 2 3-8 inches wide, it opposes less surface to wear, and is, therefore, worn down more rapidly. The tread might be made wider, but at the expense of increased weight and cost. 2nd. Because on account of the narrowness of

the groove the flanges of the wheels are continually grinding the lip of the rail and wearing it away and at the same time being worn away themselves. 3rd. Because, as soon as the tread is worn down enough to permit the wheel-flange to run on the bottom of the groove, the rail should be discarded. On this point Mr. Francis, in the paper before referred to, very pertinently says: "The flange of the wheel can never be made suitable to sustain the heavy car (unless made of steel, the cost of which is almost prohibitive, it being as 5 to 1), as its necessary form, namely, a fairly sharp edge of a circle, precludes it. At present the chipping of these flanges is a very serious matter, and it is going on so extensively that no railroad company can hope to keep up the removal of wheels as fast as required by this cause. The result is that many cars are being run at high speed with flanges very badly chipped for a large part of the circumference of the wheels, and the value of the remaining part of the flange is not in proportion to its depth, as it is so jagged and scalloped by the breaks that on the least provocation the wheel climbs the head of the rail."

The evil complained of by Mr. Francis was only such as arises from the practice of making the "special work" of street railway track, the frogs, mates, etc., of such shape that the wheels in passing through them must run on their flanges How much greater, then, would this evil be if the treads of the rails were permitted to be worn down sufficiently to throw the weight of the cars on the flanges. No doubt, also, the pinching of the flanges in the narrow grooves of the rails has some effect in increasing this evil. If to avoid it we enlarge the wheel flange, we must enlarge the groove to correspond, and its special merit of keeping out wheels disappears. Messrs. Pratt and Alden, in their treatise on "Street Railway Roadbed," page 29, say on this point: "The difference between the depth of flange and the height of rail-head above the tram or bottom of groove represents theoretically the amount of wear possible before the rail must come up. Flanges are made from 5-8-inch to 1-inch deep, generally 3-4-inch, and since the vertical flange space in the rail varies from 1-inch to 1 1-4-inches, the amount of wear available is from nothing to 5-8 of an inch, depending upon

which combinations of wheel flange and rail section come together."

The wear of street railway rails is, at best, much greater in proportion to traffic than on steam or interurban roads, owing to the vastly greater number of stops, the short distance in which the cars are stopped, causing frequent sliding and grinding of the wheels, and the dirt from which they are seldom entirely free; and the nuisance to the public arising from the tearing out of a wornout rail is so great that it should be avoided as much as possible, and the fact that one form of rail is less durable than another is a serious objection to its use. This objection does not apply to the T rail, as the groove in the paving block can, if necessary, be cut deeper as the head wears down until it has worn down to its permissible limit.

3rd. Notwithstanding the narrowness of the groove, narrow buggy wheels and sleigh runners do sometimes get wedged into it, and, on account of the vertical sides, can seldom be extricated without being severely wrenched or broken.

4th. Even under the most favorable conditions of good weather and clean streets, the full-grooved rail offers a greater resistance to traction than any other. Mr. G. S. Johnson, general manager of the Grand Rapids Street Railway, says: "The increase of power required to operate cars over tracks constructed with grooved rails is from 15 to 25 per cent." The Springfield, Mass., Street Railway Company say: "We find that it takes about 25 per cent more power to propel cars on this rail than on the T rail." The Rochester, N. Y., Street Railway Company say: "It takes vastly more power to operate." The officials of the Boston, Mass., system give similar testimony. Messrs. Lichter and Gens, Electric Railway Constructing Engineers, St. Louis, Mo., say: "Dynamometer measurements showed that with fairly clean heads and groove the traction or power required to draw one ton on level track was from 26 to 30 pounds, as against 15 to 18 pounds on the ordinary tram rail. The increase in traction is due to the flange friction." It will be remembered that on T rails on steam railways the traction is often as low as six pounds to the ton, or even less at street railway speeds of ten miles per hour.

5th. There is universal complaint from companies using this rail of the difficulty of keeping the groove clean.

In summer it becomes filled with dirt blown in from the street or brought in by vehicles from unpaved side streets, horse-droppings, and small pebbles and bits of wood and metal This evil is especially great in the smaller cities where only part of the streets are paved, and in all cities where the pavements are not kept constantly swept, a class which includes nearly every city in the United tates. Even in the Borough of Queens, where cars run at intervals of 3 to 15 minutes, and the street cleaning department has one man on every two miles, the grooved rail is pronounced a failure from this cause. How much more is it so in cities where the pavements are never swept, and are only cleaned with hoes once or twice a week. In winter the grooves become filled with packed snow, ice, and frozen dirt, especially in the early morning, where the cars do not run all night at frequent intervals to keep them open, as is the case in all the smaller cities. There being no means of draining the grooves on nearly level streets, they become filled with water on mild afternoons, which flies up on the motors in the day-time and freezes solid at night. This filling of the grooves is the cause of many evils, the least of which are the additional resistance to traction and consequent loss of power and delay in the movement of cars.

Pratt & Alden (page 4) say: "The accumulation of dirt in summer and ice in winter in the grooved rail obstructs the free passage of the wheel flange to such an extent as to increase, in some cases, the force required to move the car as much as fifty per cent."

By raising the wheel above the head of the rail the weight of the car is thrown on the flanges, which often results in their being broken, and a very small obstruction in the shape of a pebble, stick, or frozen dirt is often sufficient to cause derailments with all their delays and dangers. The gap between the wheel and the rail breaks the flow of the electric current, which is the cause of loss of power, of slow speed, and frequent stops, of injury to the motors, and, in some instances, of shocks to passengers through the current getting to the iron work of the

cars. Sometimes cars cannot be started until the conductor establishes contact by means of the switch bar, and on steep grades the loss of contact may put the car out of the control of the motorman, to the imminent danger of the passengers.

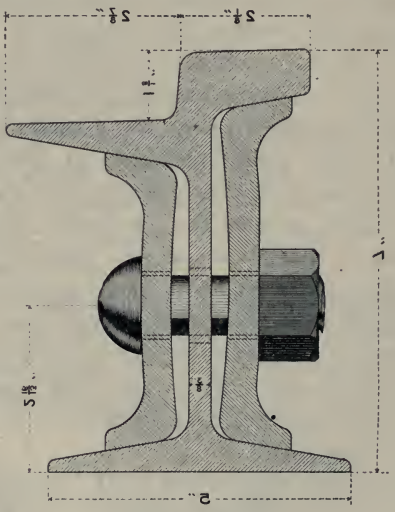
The cleaning of these grooves, however accomplished, is an expensive matter. In many cities it is attempted to keep them clean in winter by the liberal use of salt, a practice which is injurious to the rails and to horses' feet, and generally disliked by the public, but nevertheless permitted as an apparently unavoidable evil. Scrapers and brushes attached to the cars are largely used for cleaning the tracks, but they must necessarily be somewhat flexible, so as not to catch in the joints or other irregularities of the track, and therefore fail to remove packed or frozen dirt, snow or ice. In many cases the groove can only be kept clean by men with hand scrapers, and this is said to be the general custom in Europe, but the cost of this method of cleaning is excessive, and in the smaller cities would be almost, if not quite, prohibitive. Even in cities where only the special work is grooved the expense is considerable. In Saginaw, in summer the railway company is said to send out a tank car to flush out the grooves with water, sometimes two or three times a day. Even in the mild climate of Washington City the company is obliged to use diggers to keep the ice down. Indeed, so great are the objections to this form of rail that Pratt & Alden, while regarding it as the best form, are compelled to say (page 22): "No city which does not specify a first-class pavement, and does not keep its streets clean, should compel its street railways to lay such a rail." They also say (page 23): "In macadam pavements, a grooved rail would be out of the question on account of the dirt."

The evil is becoming aggravated by the growth of the interurban railway system. The light weight and moderate speed of the street car make its slender wheel-flanges permissible, though objectionable, but the heavy interurban cars, often weighing as high as 30 or 40 tons, and running at speeds of 40 miles per hour or more on the open tracks, must for safety have very much heavier flanges, and when these cars come to pass over the city tracks, as they must do for the convenience of the

traveling public, it is often a tight squeak for them to get through the grooved rails. Part of the old line in Muncie of the Union Traction Company of Indiana had grooved rails which would not admit the large flanges of the interurban cars, and in order to avoid the necessity of laying new rails, the company fitted up an emery-wheel grinding machine on a car, and ground out the grooves to the necessary width and depth.

The interurban system has come to stay, and will in time gridiron the entire well-settled portions of this country, and if to accommodate it, the grooves of the full-grooved rail must be enlarged, the peculiar merits which characterize it will very largely disappear.

Let us now consider what may be regarded as the opposite extreme, the tram or side-bearing rail. This rail has a head from 2 inches to 2 1-8 inches wide, and from 1 inch to 1 13-64



Tram Rail.

inches high above the flange, which is flat, and from 2 3-4 inches to 3 inches wide. It was first used extensively in Philadelphia, and is probably more generally used for street railway track than any other in this country. It is kept clean from dirt and snow more easily, perhaps, than any other rail, as the flanges

of the wheel can crowd much of the accumulation away from the head, and the rest is more easily reached by the ordinary brushes or tools, and, when clean, it offers no more resistance to traction than the T rail. But it has several very serious faults. It is but little more durable than the grooved rail, since, so soon as the head is worn down so that the wheel flanges run on the rail flange it should be removed. It furnishes two wide depressions, an inch or more in depth, into which every crossing vehicle must drop with a jolt, which injures the vehicle and the pavement.

But the most serious fault in the eyes of all but the drivers of heavy vehicles is the irresistible temptation which it offers to the wheels of these vehicles to follow it. The flange is broad enough to carry almost any ordinary wheel, the wheel easily drops onto it, and once there the greatly increased ease of traction and the difficulty of lifting the load up the steep side of the head keep it on until it is compelled to leave. These heavy loads wear out the rail more rapidly than do the ordinary cars, they tend to spread the rail by rubbing against the head, and to bend down and break the thin edge of the flange, especially at the joints, and with their leverage of fully 1 1-2 inches they tend to rotate the rail around the inner edge of its base, and eventually tear it from its fastenings, and break up the pavement. Wagons getting into the track and staying there are the cause of constant delay by blocking the way of cars, to the great annoyance of the traveling public. In these days time means money, and rapid transit is a necessity, and when the business man takes a street car he wants to reach his destination as speedily as possible, and the continued blocking of his car by teams on the track may often be the cause of pecuniary loss, and almost always of an amount of poorly suppressed profanity, which must be a source of infinite pain to the recording angel. Sometimes a dozen or more cars will be blocked by a single team, and so persistent are teamsters in clinging to the rail that in some cities it is necessary to instruct the police not to permit a truck to remain on the track for more than the length of one block. The public who use the street cars for transit number a hundred to one who uses the pavement, and their

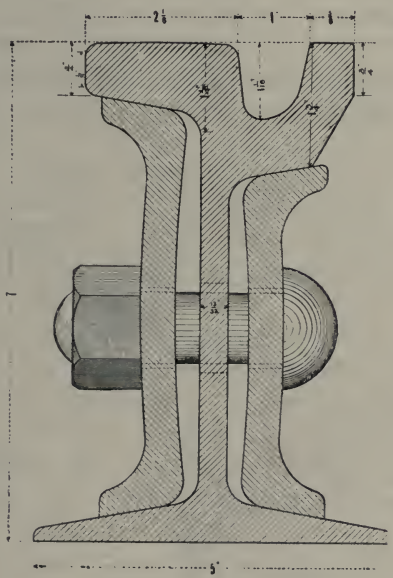
interests should be paramount. Teams can keep off the track, but the cars cannot. But it is the pavement which suffers the greatest injury. An ideal pavement is, without question, one which presents a perfectly smooth surface, unbroken by ruts or grooves, and offering no special inducement to traffic to traverse any particular line. This traffic will then be distributed most evenly over the entire surface of the pavement, and its life is likely to be the longest possible. The tram rail violates this fundamental principle by inviting the concentration of traffic on certain lines. If both wheels could follow the rails the injury would fall mostly on the railway company, but this is seldom the case. The gauge of the wheels of most heavy vehicles used in cities is greater than that of the railway, and, while one wheel travels on one rail, the other travels on a line outside the other rail and from four to fifteen inches from it, speedily wearing a groove even in the hardest granite blocks, and especially injurious to more yielding pavements like asphalt and macadam. It is an evil of most serious character, and one which it does not appear possible to do away with except by the most severe police regulations, and it is not surprising that so eminent an engineer as Mr. Whinery, in a discussion before the American Society of Civil Engineers, declares that "None of the sections like 4 and 10 (tram) should be tolerated on a paved street."

In the single case of a bridge floor of plank less than five inches thick a flat rail of the tram section seems to be the best that can be used, as the floor can be cut away to receive it, and, being double track, teams may be permitted to follow it, and will naturally do so.

The half-grooved rail is a compromise between the full-grooved and the tram, and, like most compromises, combines in a somewhat less degree all the faults, as well as virtues of both. The groove is usually of about the same size as in the full-grooved, but the top of the lip is about 1-2 inch below the head.

On account of the shape of the groove it is somewhat easier to keep clean, and wheels getting into it can usually get out with less injury, but otherwise it seems to have few especial merits.

The depression of the lip, though so small, is sufficient to make a shoulder of the head which will guide the wheels almost as well as the tram rail, with all the accompanying injury to the pavement and annoyance to the public, though it is not nearly so inviting as the tram rail and easier for the wheel to leave. The lip, being quite thin, is easily worn and bent by wagon traffic, the wheels of vehicles produce the same rotary motion of the rails, though in a less degree, as in the case of the tram-

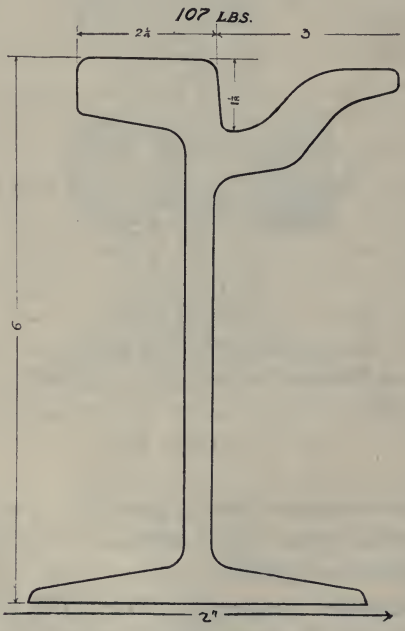


FULL-GROOVED RAIL.

rail, and there is the same lack of durability for the same reasons. On the whole, this section seems to have fewer warm advocates than any other girder.

The Trilby rail was first used in New York in 1895, and has not yet been extensively introduced in other cities. It is still therefore, rather in the experimental and transitional stage. It is a grooved rail with a projecting flange, which, with the groove, has a total width of 3 to 3 1-2 inches. The top of this flange is, in some sections, made level with the head, and in

others from 1-16 to 5-8 inch below it. There is a wide difference of opinion among the advocates of this rail as to which section is the best, and the question is still an open one. The writer has no personal knowledge of this rail, and is therefore dependent upon the judgment of others. It is advocated by such authorities as E. P. North, W. B. Reed, and the city engineers of Rochester and Dayton, and opposed by N. P. Lewis M. D. Pratt, S. Whinery, and V. Angerer. (Transactions Am. Soc. Civ. Eng., Vol. 37). The groove is more rounding than that of the full-grooved, and therefore easier for a wheel to get into and get out of. It is objectionable to railway companies on acount of filling with dirt and ice, but much less so than the full-grooved. The projecting flange furnishes somewhat of a



TRILBY RAIL.

track for wheels, especially if the flange is lower than the head, and therefore is subject to the same objections as the tram-rail but to a much less extent. For the same depth and web it

would seem to be the heaviest and most expensive of all forms of girder, and therefore poorly adapted for small cities, but for those of the largest size, where streets are kept clean, it may yet prove to be the most acceptable.

From this review it seems to be plain that no one form of rail is of such surpassing merit as to command its use in preference to all others. Indeed, it seems somewhat difficult to understand why a rail with a groove of a certain size and shape both of whose sides are steel, should be perfectly acceptable, while one with a groove of precisely the same size and shape (if desirable), one of whose sides is steel and the other a granite block or hard paving brick, is not just as good.

Since, then, the T rail is the unanimous choice of the street railway companies, it would seem that it should at least receive the respectful consideration of city authorities, provided it can be shown by experience that with proper construction it can be made quite as satisfactory in most cases as any other. Of this there is abundant proof, though the limits of this paper will permit reference to but a small part of it.

The testimony of street railway officials is unanimous. Minneapolis says: "Our experience has been that the T rail makes the most satisfactory track that it is possible to put down."

Denver says: "If care is taken in beveling the blocks next the rail, satisfaction can but result. Paving which was laid under these conditions 10 years ago is as smooth to-day as when it was put in."

New Haven says: "Teams find no difficulty in crossing this rail, and it has proved satisfactory to the railroad and the city;" also, "I don't think the city government would allow anything to be laid but T rails."

The City Engineer, Mr. C. W. Kelly, however, does not agree to this.

Rochester says (Amer. Soc. of Municipal Improvements, 1903): "It lends itself readily to the construction of smooth, unbroken pavements of brick or asphalt, and of stone, where the same is carefully cut." . . "Rochester has had such rail in her streets for years, often indifferently laid, but still showing that properly laid it is neither an eye-sore nor a public menace."

Milwaukee says: "Our officials entirely satisfied with the manner in which we lay our T rail."

Los Angeles says: "T rail has been entirely satisfactory to all, both city, railway company, and street users."

Scranton says: "Entirely satisfactory to everybody."

Bay City says: "I do not believe you could get the authorities of Bay City to put in anything else but T rail."

Among engineers there is a wide diversity of opinion. If there were anything like substantial agreement among them in favor of any one form of rail, it would be a strong argument in its favor, but this is not the case. Some prefer one form because it is the only one with which they are practically familiar. Others prefer one form because it differs from the one with which they are familiar and which they do not like. Even among engineers who have had large experience with various forms there is no agreement. The engineers of some of the largest cities like New York, Cincinnati, etc., generally prefer the full-grooved rail, and it may be fair here to admit that under the circumstances which exist in such cities, where the pavements are kept clean, where the street and car traffic are so heavy that any construction is but short-lived, and where the franchise of the railway company is very valuable, and it is abundantly able to bear almost any expense, it may be perfectly right for the city authorities to require any construction which seems best to meet these conditions.

But there is already much and growing sentiment in favor of the T rail, due, doubtless, largely to the recent improved methods of construction.

Mr. F. W. Cappelen, of Minneapolis, a prominent member of the American Society of Civil Engineers, writes: "I find the T rail is still doing well here and has come to stay. I have about made up my mind that the Minneapolis construction is about as good as can be made." (All T rail).

Mr. G. L. Wilson, Assistant City Engineer of St. Paul, writes: "I think that the construction as developed here is entirely satisfactory." (All T rail).

Mr. C. J. Poetsch, City Engineer of Milwaukee, writes: "The pavement can be connected with the T rail as well as any

other rail. There is no trouble in crossing such track construction as easily as with a full-grooved rail, except that you cannot follow a car with a team with both wheels on the track, which in large cities we are trying to avoid."

Mr. J. P. Phillips, City Engineer of Scranton, writes: "We have about 5 miles (some since 1897) of T rail track with concrete base from curb to curb in paved streets with good results and general satisfaction. The public favor this construction, for no weak spots have developed, there being no inducement for heavy vehicles to run on the track, people in street cars are not delayed by breakdowns, vehicles are not strained by continual pulling on and off the tracks."

Mr. Malverd A. Howe, Professor of Civil Engineering in Rose Polytechnic Institute, Terre Haute, Ind., and author of several valuable monographs on engineering topics, writes: "For several years now all new street rail has been of the T type. In pavements it is perfectly satisfactory. On unimproved streets it answers as well as any rail."

Mr. S. Whinery, though an advocate of the full-grooved rail for large cities, says (Transactions Amer. Soc. Civil Eng., Vol. 37): "Some recent constructions with this rail have proved very satisfactory and . . indicated that it may be made quite unobjectionable from the pavement standpoint."

Mr. N. P. Lewis, Chief Engineer Bureau of Highways, Brooklyn, N. Y., says (Transactions A. S. C. E., Vol. 37): "The writer is of opinion that in many cases there can be no reasonable objection to the use of the T rail, 7 or 9 inches in depth. The rail would undoubtedly last twice as long as that used in the other track (grooved); there would be almost no break in the surface of the pavement, and no obstruction to the passage of vehicles along or across it, while they would not follow it, and the traffic would be more evenly distributed over the entire surface."

Pratt & Alden, in their "Street Railway Roadbed," though favoring the full-grooved rail for large cities, say (page 23): "In macadam pavement T rails are without doubt the most satisfactory sections, for the reason that the street traffic on

macadamized streets is light, and usually follows its own tracks at the sides of the street."

And again (page 42): "These rails have been very successfully laid in the smaller cities in connection with well-macadamized roads and brick pavement. Even the shallower granite-block pavement may be laid with this track with success. This construction is becoming more popular as the prejudice to T rails wears away. New England has many examples of well-laid T rail track in city streets, and in connection with nearly all kinds of pavement."

With such testimony as this, and the evidence it furnishes that in such cities as Milwaukee, Rochester, Minneapolis, St. Paul, Denver, New Haven, Los Angeles, and Scranton, all of 100,000 to 300,000 population, the T rail track can be made perfectly satisfactory, it would seem that it is unjust for the authorities of cities of less population, where franchises are of much less value, to require their street railway companies to use any other rail more expensive to lay and maintain, and whose superiority in any respect is at best doubtful.

INTERURBAN AND SUBURBAN ELECTRIC RAILWAYS.

W. W. RRIGDEN.

Perhaps some have almost forgotten the horse or mule railway, or at least it has such a hazy place in memory that they almost imagine it as belonging to the realms of dreamland; others will be surprised to know that it still has a place in a few cities of our own country. We find fault with the transportation of the present electric railway, but can easily solace ourselves with the possibilities of the past. Most of us have had practical knowledge of the present system of electric railways less than ten years, yet it has a great hold on our busy city life; much more than would be possible with any system of horse or even cable cars, as the latter system is too expensive to have more than a moderate use in large cities, and the cost for those of medium population or less is prohibitive.

The track of the horse railway, even in large cities, was a flat strap rail which with present interurban cars would "roll up as a scroll," and might pay occasional visits to the interior of the car, as is said to have been the case with a strap rail on the Michigan Central Railway forty years ago.

The rapid stride of the city street railway is marvelous, but that of interurban and suburban lines is still greater, and if continued at the present rate will soon be beyond the most sanguine expectations of those engaged in the construction and operation of street railway lines five years ago.

For all the wonderful success of electric railway construction and operation, there is little room for doubt that it could be done in a much better manner than at present. Most engineers who have had any connection with steam railway con-

struction will remember the days of the narrow gauge railroad, when our friends, the promoters, told us that railway lines could be built for one-half to two-thirds the cost of those of standard gauge, if we would only let them reduce the gauge from standard to three feet or three feet and a half. It was not exactly clear how it was possible to make such a wonderful saving in construction by a reduction in the width of cuts and fills and in lengths of ties of from one to one and one-half feet, but as it was all figured out on paper and approved by many engineers who claimed that they were competent to sit upon the question, it was accepted by many of the profession and very generally by the public. Clear-headed engineers of experience denounced the whole matter as a fallacy that would soon be exposed; but this had little or no effect on those who controlled many railroad lines, and narrow gauge construction was carried on only to turn out at nearly the same cost as a standard gauge road, and then after a few years it became necessary to interchange business with other lines, to widen the grading and put the narrow gauge lines to standard gauge at enormous expense for construction, delays in traffic, and change of rolling stock.

The constructors of interurban railways are following in the lines of the narrow gauge projectors. An extremely narrow right of way is purchased, say twenty feet wide, and the track is made to fit it,— or worse, the line is laid largely along public highways. Sharp curves and heavy grades are introduced at many points to save present expense, and these will either handicap the road so that it can never do a first-class business or will require the reducing of curves and grades to meet the necessities of traffic, and, the cost will be far beyond what it would be if done in the beginning. It is said that in some cases alignment has been altered to miss a tree. Ask any old trainman what would become of a train of twenty or thirty freight cars, such as are run every day on steam roads, if it was jerked, slacked up and then jerked again by being pulled fifteen to thirty miles per hour along a road with a descending ten per cent grade 500 feet long followed immediately by an ascending one of the same slope, with occasionally a curve of say 300 feet radius thrown in. The crew would have to be lashed to the

cars or lie down and hold on for dear life and the train would separate into sections that would strongly dispute each other as to the right of track, and the weakest would have to give way.

The matter of right of way is not always the fault of the interurban officials as in many states there is as yet no right of eminent domain giving the street railway lines, by which they can compel the sale of land in case of refusal by the property owners. But in many cases land could be obtained of sufficient width if the railway was willing to pay the price. Some few lines constructed by people with abundant capital and under the supervision of steam railroad civil engineers of experience have followed very closely in the lines of the best steam railroad construction, and these lines will be found greatly superior to those constructed in the ordinary manner.

Conducting the requisite amount of current from the trolley wire or third rail to the moters on the cars is not so easy a task as was anticipated. It has been shown that the ordinary trolley wheel will not do for heavy cars and high speeds, and even two trolleys is not enough. A cast iron contact shoe attached to the sides of the car and sliding over an extra rail located about one and one-half feet from one of the track rails has been found to answer much better; but it is not probable that a third rail will do the work under circumstances likely to come up in the near future, and many electricians are looking to the use of alternating currents at a much higher pressure than 500 or 600 volts; there are several of these lines in operation. But the difficulties and dangers involved are not yet sufficiently provided for to satisfy many of our best electricians, and the tendency in the United States is to adhere to low pressure and direct current, using the trolley for city work and the third rail for interurban lines. With the aid of storage batteries to equalize the great differences in pressure due to irregular demands for power by electric cars the present methods work very well, if the power house is properly equipped, and the sub-stations to convert the high pressure alternating current to low pressure direct current are not over ten miles apart.

In many cases the contract for the construction of an interurban line is let to a construction company with little or no restrictions beyond the outline on which the line shall be built; the nominal company has little or no money, or means of obtaining money, and the construction company owns and controls everything, sometimes even to taking over the line at the end of its construction. The construction company often pays and controls the engineer, although he may be appointed by the company. This ,of course, is a state of affairs that can only result in disaster to the final owners of the road.

From present appearances it would seem that very few lines will remain in the hands of the parties who originally constructed them longer than five years. Consolidation is the order of the day and even well constructed lines with abundant capital will fall into the hands of those who have greater capital and who are seeking for the consolidation of several lines reaching from one large city to another. The whole of the lines from Cleveland to Toledo are already under one management. All the lines in and about Detroit are under one management, with a single exception. If we are to judge from steam railway practice the system of consolidation will rapidly continue until only those will remain that are separated geographically, or are of such strong financial standing that they are able to hold their own against all others.

When we are aware that the increase, in a number of our Northern States, has been in the past year from 40 to 100 per cent in the number of cars used, and that the number of miles of track has nearly kept pace with the number of cars, we are able to form some idea of the rapidity with which we are increasing our electric railway system. It seems that there is but one thing that will stop this boom,— that is, the coming of the usual panic following great expansion like the present. This is sure to come, and when it does, nine-tenths of the street railway projects will fail of materialization until better times come again. Still it does not seem that capitalists should be discouraged to the extent stated, when we consider the prosperity which has fallen to some of the lines in our own state. It is asserted that the Detroit, Ypsilanti, Ann Arbor, and Jackson

Railway Company has created traffic to the extent of twenty-five times the traffic enjoyed by steam roads previous to the construction of the interurban line. It is quite evident that only a small portion of the traffic has been diverted from the steam roads, and yet this diversion in some cases has been as much as one-half or two-thirds of the local traffic of the steam line.

It is more than probable that electric railways will soon reduce the expense of travel for moderate distances, so that the traffic will be increased beyond that of steam railways to as great an extent as the steam railway has increased travel over that by boat and stage. The electric railway makes a charge of from one to one and one-half cents per mile, while the steam railway charges from two to three cents. Local fares on the Boston and Worcester Street Railway are but one-half that on steam railway lines, and in many cases they are but one-third.

As soon as electric railways can make an average of from twenty to thirty miles per hour, and a number of them are already doing this, there should be a large diversion of the traffic due to the lower rates and the convenience of the electric lines. The distance from Battle Creek to Detroit is about 120 miles. The time by the Michigan Central is from three hours to four hours and twenty minutes, but one train making the trip in less than about four hours. A good interurban line should be able to make the trip in about six hours. It is probable this time can be reduced by the electric railways after some practical experience, but should it remain at a difference of two hours it is quite evident that more people will travel by the interurban line, as the saving in fare would be about sixty cents and this would pay for the extra time of nine-tenths of those who would desire to make the trip.

The first difficulty will be the passage through the larger cities and towns, where the speed will be reduced because of local regulations and the slow speed of local cars. Whether this difficulty can be remedied is more than the writer can say. In Battle Creek it would be almost impossible to construct a line passing through streets in the central portion of the city on which high speeds could be maintained. This would not be equally true in cities with uniformly parallel streets, but even

there it would be no easy task, and it does not seem probable that anything like steam railroad speed could be reached. If lines were constructed not passing near the centers of cities, it is probable that a large portion of the traffic in the cities in question would be lost or endangered by the inconvenience attending getting to and from cars. The present interurban line from Detroit to Jackson exceeds an average speed of twenty-five miles per hour between terminal city limits, and this, no doubt, can soon be reduced somewhat. That these difficulties will be ultimately overcome is the belief of the writer, and the electric railway will equal the steam railway in speed. Already there are frequent cases of speed reaching from 40 to 50 miles per hour, and occasional tests are on record where the speed has been carried up to 60, 70, 80 and even 100 miles per hour. Present construction of electric roads does not, however, admit of speeds beyond 80 miles per hour, as the best track and braking facilities are not adequate for higher speeds.

The electrical equipment of a street railway is very difficult for civil engineers to understand, and perhaps will remain so, although it appears that no one could so well conduct the original construction and operation of an electric railway as the well-posted railroad civil engineer. Not only has he the knowledge of earthwork, curves, flow of water, grades, bridging, fencing, and track-laying operations, but those endeavoring to instruct beginners in electrical matters almost invariably use the flow of water in pipes as the nearest illustration of the flow of electricity in wires.

It has been said that no adequate compensation can be had by engineers on the average electric railway, and that his position is not clothed with much authority. This should not be the case, and it would appear that railway civil engineers should be the men to conduct the general construction work of electric lines. It would no doubt be wise to employ electrical experts working with or under the direction of the civil engineer, but as this would bring about a duplicate set of high-paid officials it would probably not receive favor with many street railway promoters. The cessation of steam railway construction that has taken place of late would make steam railway civil engi-

neers available in large numbers for the construction of electric railways and no doubt many of them are so employed, but where employment can be obtained on steam roads the compensation is so much greater that few will make the change. It is certain that their advent on electric railway construction and the following of steam railway practice in width of right of way, grades, alignment, width of embankments and cuts, and all the experience gained on steam roads would be very valuable in the construction of interurban lines. Judging from the experience of the writer, it is quite certain that it would need but little instruction in electrical matters to make a steam railroad civil engineer far superior to the so-called electrical engineer or expert provided by the average interurban managemnt. Few of these experts have a well-founded knowledge of even the elementary principles of electricity.

If an investigation was made it would no doubt appear that nearly all the older lines are not provided with sufficiently large wires, and that there is current lost in the transmission of power from the power house to the cars, and comparatively greater loss in the return current through the rails to the power house. In the matter of the return currents the practice in the United States has been so deficient that in several European countries, where these matters are in the hands of real electrical experts and where the interests of the municipalities and the public are very much more closely guarded than here, there has been a complete modification of this portion of the electrical outfit, and the loss by the return currents are reduced to about one-twelfth, and in many cases to one-twentieth that allowed in American practice. Drop in pressure on many lately constructed or reconstructed lines amounts to as much as 30 to 80 volts, while in Great Britain it is restricted by the Board of Trade rules to 7 volts, and many lines have reduced the loss to about 4 volts. As some well bonded electric railways have cost as much as $40,000 per mile, or at least they are capitalized to that amount, it would seem that better construction than before outlined should have been easily obtained. The only alternative to this conclusion is that the stock of the electric railway is watered beyond any reasonable allowance.

As steam engines, boilers, generators, motors and cars are largely provided by great corporations whose reputations are at stake, and they have the knowledge necessary to bring about good results in these lines of electric railway construction, there is less opportunity to criticise than in those that have been mentioned, although the rolling stock of some of our present street railways would hardly bear out this statement.

One evidence of the progress of interurban railway construction is shown in the increase of the size, weight, and power placed upon the present cars of the better class. We were once well satisfied with cars 18 feet in length and weighing a few tons and there were many examples of less size than this. Since the advent of interurban and suburban lines, cars have been increased to 40, 50 and even 60 feet in length, and the weight has been increased until the present standard cars constructed weigh from 20 to 40 tons. The larger of these cars are very similar to our better steam cars and will seat the same number of people. The New York & Fort Chester Suburban line proposes cars that cost $8,000, and these are to be provided with motors costing $13,000. Even with the present large cars, the unit capacity has been too small, and some roads are running trains consisting of three or four cars.

The success of the passenger service of electric railways seems to be assured, and in a number of cases quite satisfactory results have been obtained in freight traffic, although as yet this is very small compared with that of steam lines of even the lower grades, and it is not yet clear to the managers of such roads how a large traffic can be had under present conditions. More difficult problems have been solved, however, and it would not be at all strange if a few years would see this accomplished in the case of some of the lines under the most favorable conditions. Freight cars are run singly and in trains, and in several cities freight depots have been constructed and used jointly by the interurban roads entering the place. That electric railways should be able to move heavy freight long distances at the rate charged by steam railways, which frequently does not exceed one-third of a cent per ton per mile, and in a great many cases is not over one-half a cent, does not seem to be at all clear. It

certainly would require a radical departure from any present known methods and would involve the construction of very long lines and the liberal interchange of cars between roads. Some interurban roads are already making a freight schedule on local traffic at the same rate as steam lines. Steam railroad superintendents have spoken with contempt of the work of the interurban superintendent, but it is certain that the future of the latter will keep him well and fully employed, and there is an opening for not only the ordinary man, but for those with marked ability. This class will soon be attracted by the problems that are sure to arise.

In conclusion it may be allowable to predict, but with much hesitation, the possibilities of the future. Edison's new storage battery running ordinary city cars; steam railways operated by electric locomotives with high tension current, the steam locomotive having gone to the scrap heap; the whole country covered with electric lines making a hundred miles per hour under favorable circumstances; water-power so developed as to do a large portion of the world's work, and power-house engines realizing in actual useful work many times the paltry four per cent of heat units now obtained from coal.

SOME DEBATABLE POINTS IN MASONRY.

E. W. MUENSCHER.

The extension of the Manistee and Grand Rapids Railroad to Tustin, in 1900, compelled the construction of an overhead bridge at that village by the Grand Rapids and Indiana Railroad Company. The bridge is a very small affair, consisting of riveted steel girders resting on stone abutments, of only 18 feet clear span, and 19 feet clear headway above the rails; but in the construction of the abutments some methods were adopted which are at least not common, and may possibly be of some interest.

The abutments are built of sandstone from a quarry near Lancaster, Ohio, in courses averaging about two feet in thickness. The blocks were all dressed at the quarry, and numbered to correspond with numbers marked on the working drawings. This saves much freight on useless material, and much labor at the bridge site, and would save much time in erection if every block should be on hand when wanted; but in this case much delay was occasioned by the blocks failing to arrive in their proper order.

The first departure from ordinary practice to be noted was the manner in which the beds of the courses and the face batter were formed. Instead of the usual practice of making the beds horizontal, and dressing the face stones to the proper batter, the top bed of the foundation course, which was a mass of concrete, was made inclined at right angles to the intended batter, and all the other courses had their faces normal to their beds. This practice, though not entirely novel, is not common, but it seems to be well worthy of imitation, as it not only effects a small saving in the labor of dressing the stone, but it adds materially to the stability of the abutment, both against sliding and overturning, since every stone must be lifted through a greater height before it can be overthrown than if the beds

were horizontal. It may be objected that water may enter the inclined joints and be carried to the backing, but with proper care this need not produce any serious evil.

A second peculiar feature in this structure is the entire separation of the wings from the body of the abutment, there being no bond whatever between them above the foundation. While it is a well-established practice in the construction of long walls of concrete to divide them into independent sections from twenty-five to forty feet in length, to provide for expansion and contraction, the writer was not previously aware that this method of construction had been introduced into stone masonry, or that there was any necessity for it, though he has since been informed that it is now the general practice on the Pennsylvania lines west of Pittsburgh. The reason given for this innovation is that if one portion of the abutment should be overthrown by excessive pressure, the remaining portions, being entirely independent, would not suffer with it. If the intention is to design every part of the structure so economically that it shall be just within the danger line, this may be very good logic, but it would seem to be much more consistent with sound engineering principles to design every part so that it will be abundantly strong enough to resist any pressure that is likely to be brought against it, and that in case, through any accident, some portion should be subjected to excessive strain, it would be much more likely to escape destruction if aided by the resistance of the other portions than if compelled to depend upon its own strength alone. At all events, unless convinced to the contrary, the writer would prefer not to imitate this example.

A third feature, which, though not novel, is a still wider departure from usual practice, was the lavish use of grout. No beds of mortar were used. The stones in each course were separated from each other and from the course below by small blocks of wood, of the thickness of the proposed joints. When the entire course was set, the outer edges of the joints were filled with stiff mortar to a sufficient depth to make them watertight, and a grout, necessarily very thin, was then poured in from above from a spout until all the joints were filled and the grout flushed to the surface.

It is claimed by the engineers of the Grand Rapids and Indiana Railroad that this method of construction has proved entirely satisfactory on that road; but it is so contrary to the almost universal judgment of authorities upon masonry that, in the writer's opinion, it should not be adopted without a thorough investigation of structures which have been built in that way. While under careful inspection it might be satisfactory, there would be great danger that, without such inspection, it would too often result in structures but little, if any, better than dry walls.

THE ENGINEER AND THE PATENT OFFICE.

GEO. B. WILLCOX.

We will consider for a moment the close relationship that exists in fundamental principle between this engineering profession of ours and the department of our government which is responsible for the existence and development of that creative genius known as the American inventor.

The field of usefulness of engineering in general is well outlined in the constitution of a brother engineering society which declares its purpose to be "to promote the acquisition of that knowledge which is necessary to enable the engineer most effectually to adapt the achievements of science and art to the use of mankind."

Compare this constitution with the clause in the constitution of the United States which specifies that one of the functions of our government shall be "to promote the progress of science and the useful arts by securing for limited times to inventors the exclusive right to their discoveries." Upon this clause is built the massive patent system of the United States.

By this comparison we see that in the last analysis, the engineer and the patent system have but one common object for their existence, and that object is to further civilization by the advancement of science and art.

In the abstract the patent system exists to stimulate creative and inventive ability, and the engineer exists to adapt the achievements of the inventor to the use of the people. This close relationship between the engineering profession and the patent system of our government necessarily implies that the individual engineer must come into more or less intimate contact with the practical workings of the machine by which the patent system shows its results. This machine is the Patent Office.

Nearly all the improved methods, appliances, and machines used in engineering work are or have been subjects of patents. Nearly all engineering contracts and specifications contain

clauses in which one of the parties agrees to protect the other from loss by reason of infringement suits. These specifications are either drawn up by the engineer who has charge of the work or approved by him, and he should know their nature and effect. He should be able to tell with a reasonable degree of certainty whether a given device is or is not covered by a given patent, and whether the making of it would create liability for infringement.

He should know how to tell what rights a patentee has under his patent, and to indicate where the patentee's claim of monopoly ceases to be a just claim and becomes an imposition,— in other words, he should know how to determine the "scope" of a patent. He should be able to intelligently advise his employer whether a certain patent would be a good investment, and to point out what features of the invention are covered by the patent and what features are not.

It is true that patent office practice and patent litigation are specialties, and that the duties of the patent lawyer constitute a profession in themselves,— but it is none the less true that every engineer ought to have a reasonably clear idea of the nature of a patent, and of so much of its technical make-up as will assist him in determining for his clients or employer many of the patent questions that invariably arise.

It is not the purpose of this paper to evolve a treatise on patent office practice, but if it can indicate a few points about patents that are commonly misunderstood, it will fulfill its object.

Let us take an illustration:

There is a dust separator that takes the dust and shavings from the ventilating pipes of a factory, separates the air and discharges the dust and shavings into the fire room to be used for fuel. The separator is merely a huge stationary sheet-iron cone that stands small end down on the roof of a boiler house. The air blast from the ventilating fans blows into it tangentially and swirls around inside. The dust flies to the circumference and slides down the cone, dropping into the furnaces while the air escapes above. A very simple and effective device,— patented.

A contractor undertook to erect and equip a furniture factory. The specifications for the factory had been written by the consulting engineer, and in them was required a dust separator for the boiler room.

The contractor purchased some sheet-iron, built the separator, and thereby saved a snug sum, for these separators bought ready-made were expensive.

The factory was put into commission. Everything worked smoothly, and furniture commenced coming out of the shipping department. At the other end of the plant the dust separator was doing its duty. Then came a man from the dust separator company. He sought the president of the furniture company and demanded payment of royalty for the use of that separator. The president referred him to the company's attorney, who found in the contract that had been written by the engineer, a clause whereby the contractor agreed to save the company from loss by reason of patent infringements. This clause speedily shifted the field of action from the company to the contractor who built the plant. So the man left the president and sought the contractor from whom he demanded royalty. "What? Pay you for using a tank like that — a thing that any one could build in half a day? I think not!" And the contractor became indignant and swore. He vowed that he would spend his last dollar in lawsuits before paying a cent in royalties. He declared the patent worthless, and otherwise indicated that he was displeased. He said he had had no intention of infringing any patent — did not know that he had infringed — in fact, the separator should never have been patented because he remembered as a boy forty years ago seeing just such a device in use. He could prove it, and would spend thousands in doing so — but not a cent would he pay to this stranger for the privilege of keeping a machine that he built with his own material and labor.

Furthermore, he doubted that the patent covered his separator, and to satisfy himself on that point conferred with his friend, the engineer.

Together they examined the machine and the patent, and the engineer reported that the separator seemed to be an exact copy of the patent. The separator man produced court deci-

sions holding that his patent was valid — and gave the contractor his choice: to pay, or defend a suit for infringement. He paid.

But the idea is still deeply rooted in his mind that the patent system is rather an instrument for promoting legalized robbery than for promoting science and the useful arts.

He could see neither right nor justice in being forced to pay this stranger a profit on a machine that he himself had made.

A small amount of light on the nature and purpose of a patent would have given him a clearer view of the matter.

What is a patent under our American system? What is its purpose — what rights does it give its owner?

First, and most important, a patent is a certificate issued by the people of the United States to one who has made an advance or an improvement in a useful art. It is in the nature of a reward of merit, and it says to the inventor, "Produce a new and useful invention in any art and we will reward you, not by paying you money from the treasury, but by giving you the legal right to prevent all others from making, using, or selling your invention for the term of seventeen years. If your invention is new, you will have a monopoly on it, thus you will be the only person in the country who can during that term legally use your invention. If others commence to use it you can go to a United States Court, and by proving that any one is making it without your permission, the court will compel the infringer to pay you damages."

Note that the patent does not give the inventor the right to make the invention, for that right is part of his citizenship, but it does give him the right which without the patent he does not possess, to prevent others from making the thing which he has invented. It is a monopoly granted for a short term to reward him for his labors. He is free to make the most of his opportunity, or to neglect it, but when the term expires his invention is ever after free to the public.

Our friend, the separator man, had invented this very simple and effective dust separator. It was a distinct improvement over former separators. Several courts had decided that his

patent was valid and he stood on a firm base. It may be remarked here that a patent that has been litigated and found good is more valuable than before it was tested, for the reason that the Patent Office, while usually accurate, is not infallible, and it sometimes overlooks old devices while searching to find if an invention is new, and grants patents on them that should have been refused. An inventor or the purchaser of a patent is therefore never sure of the validity of his patent until the courts have decreed it at the end of a lawsuit. This inventor was clearly within his rights in requiring the contractor to pay him royalty, and what appeared to the contractor to be an injustice was to the inventor only the exercise of the legal rights that the people had granted to him as his reward for making a valuable improvement in dust separators.

This is a case where the patent was valid and where infringement was acknowledged, but in the vast majority of cases the validity of the patent and the question of whether or not it was infringed are matters that require extended litigation to decide. Some patents are clearly novel. They light upon a field that has never before been touched, as did Bell when he invented the art of transmitting sound by electric vibration. Such inventions are very rare. The great majority are minor improvements and they are necessarily covered by minor patents. If a man makes a big improvement his patent gives him the greatest right of exclusion. Anything approaching his invention is an infringment, but if on the contrary the invention is a little one, a mere improvement over former devices, his patent will be a little one, and his right of exclusion will be limited to the particular improvements that he has made. Therefore there are as many kinds of patents as there are of inventions. Some are broad and very valuable and others are narrow and useless. There is nothing on the engraved cover of a patent to tell whether it is a broad or narrow one. They all look alike on the outside, and the specification and drawings may describe what appears to be a very broad invention in what is actually a very narrow patent.

How then are we to tell whether a patent is broad or narrow, and whether a given device infringes it? As every one

knows, a patent consists of four parts. First, the grant, which is the certificate just referred to. Second, drawings showing the invention and its mode of application. Third, the specification which describes its construction and operation. This specification is merely for the purpose of enabling persons skilled in the art to make and use the invention. Were it not for this description in the specification of the patent, the public could not benefit by it after the patent expired, because there would be no record of the construction or operation of the invention, and it must be remembered that the public is to have the full benefit of the invention after the patent expires. The specification may be very broad and general in some of its terms, but since it is merely for the purpose of explaining and illustrating the invention it is not a gauge by which to determine the breadth of the invention.

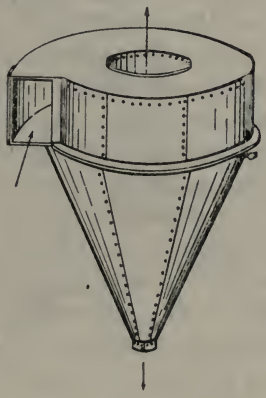
The fourth part of the patent is the main part, and in many cases the one part which needs to be considered by the interested engineer; that is, the claims. At the end of every patent there are one or more short paragraphs which clearly point out and distinctly claim the improvement. If the improvement is a broad one, the terms of the claim are broad, but if it is a narrow one the terms of the claim are restricted in scope.

Let us take for instance one of the claims in the dust separator patent just mentioned. The claim is what is known as a combination claim, describing a machine made up of elements each having its own function, but all operating together to produce the results accomplished by the complete machine. It is about as follows:

"The combination with a tapering separating chamber of an inlet delivering dust-laden air to the large end of the separating chamber; an air exhaust at the large end and a depressed dust discharge formed in the side of the tapering chamber, and having a discharge-opening at its small end."

We notice on reading this claim that the first element is a tapering separating chamber. Then there is an inlet spout at the large end of the chamber, an air exhaust at the large end and a discharge opening at the small end. There are no limitations in the claims as to how the machine shall be constructed.

It does not limit it in size or material or detail. The court had in a previous suit looked upon it as a new invention, and said "the evidence establishes beyond any doubt that the machine is highly successful, and that no other device of its form or substantial mode of operation was ever before employed in the art to which it has been put." This then may be considered a broad invention. The inventor had by his patent the legal right to exclude others from making not only the particular shape and construction which he showed in his drawings and described



in his specification, but he had also the right to exclude any one from making any device that accomplished the same result, namely, separating dust from air; by substantially the same means, namely, blowing the mixture into a cone and whirling the dust out by centrifugal action. He had this right simply and solely, because the claim of his patent was broad enough in its terms to cover all similar devices.

Suppose, being entitled to make this broad claim he had neglected to do so, and had claimed merely the specific working details of the preferred form of his machine: he would then have been powerless to prevent others from making the same machine in a substantially different form because the court would hold, when he sued some one for infringing, that the narrow claims of his patent did not describe the defendant's machine.

Claims are construed literally, and if it is found that the inventor has through his patent solicitor accepted a narrow claim where he was entitled to a broad one, it will be assumed by the court that he has dedicated the broad invention to the public.

A patent claim works both ways. It outlines by the scope of its words just what it is that the inventor intends to prevent the public from using; and it is also notice to the world that everything shown in the drawings and specifications, but not claimed in the claims, is abandoned to the public. The inventor cannot reclaim at a future date what he has once abandoned.

It is surprising that the majority of inventors understand so little of the full value of their claims. They usually believe that everything shown or described in their patent is covered by it, whereas, a careful perusal of the literal meaning of their claims often shows that only an unimportant part is covered.

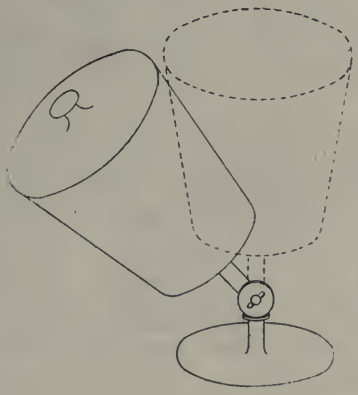
Many inventors look upon a patent as a document issued by the government for a stipulated fee, its object being to confer on the inventor a badge of distinction,— officially recognizing in him the existence of a superior sort of creative ability — a kind of index finger of the government, pointing him out among the thousands as an "inventor." He even brings himself to believe that the red seal and green ribbon is a guarantee that his invention is very valuable, and being valuable, that sooner or later it must bring him a fortune; and he accordingly roosts high.

A few words about a case of this kind may not be out of place. In this instance neither the inventor nor the capitalist understood the scope of the patent.

The capitalist owned a large pail factory, and when the inventor came to him with the model of an ice cream freezer, the manufacture of which could easily be made a branch of his business, the capitalist took kindly to the idea. The inventor made some ice cream for the office force, everybody was pleased and pronounced the freezer a great success. It was like the ordinary freezer except that it was mounted on a ball joint so that it could be tilted at any angle. When so tilted the cream flows in a thin layer on the side of the can and the freezing mixture gets a good chance at it. So with a very small amount of ice

this freezer makes either a teacupful or a larger amount of cream at a time, as desired. The capitalist thought the tilting idea was a good one, saw that it was well illustrated in the drawings of the patent, and that its importance was fully set forth in the specification. He therefore agreed to buy the rights for three States for $1,000.00; but the inventor was a stranger to him, and how could he prove his ownership? The patent was referred to a patent attorney with instructions to ascertain if the title was clear.

Since the tilting feature was the main consideration, the attorney was curious to see if the patent was broad enough to prevent any one from making any kind of tilting freezer without the owner's consent. . There were ten claims in the patent, but they all related to particular combinations of mechanism. Why was there not a claim calling broadly for an ice cream freezer that tilts? The attorney sent to the Patent Office and



bought a copy of the contents of the patent file-wrapper. (These copies can always be had by paying the cost of typewriting them, because when a patent issues all of the letters passing between the inventor's solicitor and the Patent Office are open to the public.) From this file wrapper he saw that the inventor considered himself entitled to a broad patent on the tilting freezer, because his application as originally filed contained the following claim, which is certainly broad enough and would have

given the inventor sweeping rights over tilting freezers. It reads as follows:

"A suitable support, a freezer mounted thereon by a joint that permits inclination of the freezer and means for retaining the freezer in the desired position."

Could anything be broader than this? Any kind of freezer mounted on any kind of a joint that permits the freezer to tilt in any position. The use of the tilting feature was found to be very valuable, and if this claim had been allowed, the patentee would have controlled a very valuable device; but it was not allowed. Patents are only granted for new improvements things that have never been known or used before. The public does not reward one who picks up an old device even though he does it innocently. The Patent Office is filled with experts whose business it is to ascertain whether an invention has ever been used before. They are required to search every record at their command, and if they find that a device described in the claim is old they reject the claim. That is what happened to the claim just read. The examiner at the Patent Office found an old patent which showed an ice cream freezer that tilted. This old patent did not claim the tilting feature broadly, although it was apparently the original tilting freezer. It did however, show this feature, thereby abandoning it to the public. Since it was public property, our inventor had no right to come in later and claim it for his exclusive use, and the examiner accordingly notified him that his claim for the tilting feature was rejected. He therefore was obliged to confine his claim to his particular form of joint, which was new, and to other new improved details of the freezer.

The patent attorney made his report to the capitalist and told him that the tilting feature was public property and he could not monopolize it by buying the patent. He dropped the deal, and the next time a patentee came to him with an invention that appealed to his business instinct he examined the claims of the patent instead of the drawings and specifications.

The two illustrations I have given are merely samples of cases that may arise in the daily practice of any engineer. He is sure to be called upon some time to examine a patent and

to advise some one whether it is good, bad, or indifferent. There is no more complicated field of research than that of patent law and patent litigation, and the study of this subject is a specialty for the patent lawyer, but there is no class of men better fitted to examine and compare the technical differences between inventions than are the engineers, the aim of whose profession is so closely in line with that of the Patent Office.

Professor Cooley.— If an employee makes an invention and patents it, does his employer have any rights under the patent in the absence of a contract between them?

Mr. Willcox.— If the invention is developed on the employer's time, with his tools, and if the employee makes no objection to his employer using the invention before the patent issues, the employer has an equitable right and license under the patent after it issues, and can continue to use the machine.

If, however, the inventor does not use his employer's time in developing and experimenting, and procures the patent without expense to the employer, the latter cannot appropriate the invention and has no right under the patent.

Mr. Strong.— I would like to ask one question in view of the question Professor Cooley asked. Would it be easily possible for a person to steal an invention and patent and hold it?

Mr. Willcox.— No, sir. An invention, in order to be validly patented, must be applied for by the actual inventor. If A is working on an invention and B sees the device and then applies for a patent in his own name, he must, of course, swear that he believes himself to be the original and first inventor. The courts will declare the patent void if it develops that the oath was subscribed with fraudulent intent. The true inventor's rights are not prejudiced by interlopers.

Mr. Brigden.— But suppose B gets his claim into the Patent Office before the true inventor files his application?

Mr. Willcox.— Then A, the true inventor, must prove that the invention is his. The burden of the proof is on him. Proofs in writing are best.

Inventors would be less liable to loss if every time they make an invention, they would make a sketch of it, write out a description of

its construction and operation and advantages; date, sign, and have the sketch witnessed by several persons. Then file it for future reference. Definite written evidence, supported by the sworn statements of the witnesses that they signed it at that time are good proofs of ownership and very difficult for the other side to overthrow.

To prevent others from appropriating the results of your inventive labors the safer plan is to keep your idea secret until you develop the completed invention from it; as soon as the invention takes sufficiently definite shape, make your drawings and description, and have them dated, signed, and witnessed. Then use due diligence and put the invention into practical working shape as soon as possible. When it is complete and practical do not hesitate to make it public even if you have not applied for a patent, the fact of your invention will thus become firmly established. You may make and sell all you please before applying for your patent, but you must apply within two years from the date of invention.

Dr. Lane. — I want to ask if an inventor refuses to manufacture his patent for a reasonable length of time, can he prevent others?

Mr. Willcox. — Yes. His right to exclude others runs for seventeen years. That is his time for profit. At the end of the seventeen years the invention is open to the public. While his monopoly lasts, he can make or refuse to make, as he deems best. In most foreign countries the duration of the patent depends upon the invention being worked within a certain period, but the U. S. system has no such restriction.

Mr. Holmes. — If at the end of seventeen years a man can show that he has not made a financial success of his invention can he get his patent extended?

Mr. Willcox. — Such extensions are prohibited by the Patent Act of 1861.

Mr. Hubbell. — We have often heard that a man is allowed to make a patented article for his own use. Is he an infringer?

Mr. Willcox. — If the use is purely for experimental purposes, to demonstrate the practicability of the invention he may do so, but he becomes an infringer if he puts the machine into commercial use for the purpose of making money out of it.

Mr. Hubbell. — At the World's Fair was shown an apparatus for painting by compressed air. Suppose it was patented, but the

inventor had never put it on the market. Many companies made them for their own use. Could the inventor refuse to supply the demand and still hold the companies for infringement?

Mr. Willcox. — He could, providing his patent were valid. His right of exclusion runs for seventeen years. Some countries require an invention to be worked within a stated time, else the patent falls. But there is no compulsory working in this country.

SEWAGE DISPOSAL.

W. S. SHIELDS.

In reviewing the achievements attained in the science of sewage purification during the past year, we find but little progress made, or data of a reliable nature offered. Several articles touching upon the septic tank, its uses and position in sewage disposal works, have appeared in our journals, but even they have a tendency to confuse rather than assist the engineer seeking practical information.

A few small plants have been constructed through the West but the general feeling among city officials having the charge of the affairs where works of this character are needed, is to wait further developments; they express hope that some other city will install some of the bacteriological plants, and demonstrate to the public their success or failure, and it must be admitted that their judgment is well founded and sound, when looked at from their point of view.

To a close student of the subject who has watched the development of the present biological process as practiced and given to the profession through the English and American publications, it is evident that there is great merit in them, and that it deserves most careful consideration. There is no doubt that it is well adapted to the usual requirements of our smaller cities and institutions when properly constructed and operated. Its application to large cities remains yet to be proven to the satisfaction of the average city official.

One of our difficulties seems to be that each engineer having charge of the designing of a plant of this nature incorporates his own ideas of the style, form, and construction of the septic tank, and the method and arrangement of the subsequent treatment; the result is, that the few plants now built are so dnfferent in character that a fair comparison is difficult.

It has been fully demonstrated that for the smaller installations at least, the septic tank has its place and can be relied

upon to break down and liquify the suspended matter contained in the sewage. It is also known to a certainty that the septic tank alone will not purify sewage to such a degree that putrefaction of the effluent will not follow, if it be not diluted or receive further treatment, and that any treatment of septic effluent must be aerobatic in its nature. It is in the study of methods for aerating and oxidizing septic effluents that greatest progress will now be made; oxygen must be restored and nitrification produced. This may be produced in many ways, those most in use now are by dilution in running wastes, contact beds, double or single, artificial filter beds worked intermittently, and continuous or intermittent percolating filters.

Where a good septic effluent can be discharged into a stream of running water having volume equal to the quantity of effluent with fairly rapid velocity and plenty of free oxygen, there should be no objectionable effects produced. If, however, the stream goes dry during certain seasons of the year, further treatment should be provided.

I have had very good results in several cases constructing sand filters by simply excavating, say four feet below the surface and filling the lower three feet of this excavation with graded sand and gravel; say twelve inches of coarse gravel, eighteen inches of fine gravel with a top layer six inches in thickness of coarse sharp sand.

Under drains are laid in the bottom and surface carriers over the top for distribution. The area should be divided into at least six beds by low embankments of sand which can afterwards be used to replace the surface scrapings of the beds, the scrapings in turn are placed in the embankment where they will become cleansed by the time the beds next receive attention. Each bed should have an independent supply pipe, and whenever the available fall will admit of it, a dosing chamber with a capacity for holding sufficient sewage to flood such bed to a depth of four to six inches at one discharge. Beds of this character can be depended upon to filter effluents at a rate of from 300,000 to 500,000 gallons per acre per day.

The dosing of the beds should be done automatically in order to get best results. English authorities claim twenty-five

per cent greater efficiency and capacity from beds operated automatically, than from plants operated by hand, and the claim is reasonable for an over-dose clogs a filter to an extent that it will not rid itself by the time it receives the next discharge, and no attendant, however faithful, can secure the regularity which is obtained by a device not too complicated, and operated by the flow of sewage.

Where sufficient fall for operating a dosing chamber is not available the beds can be dosed by allowing the flow to pass to such bed for a fixed period of time, which may be varied to give best results from the character of sewage and nature of the beds, probably varying from two to twelve hours, this can be done with a six-inch loss of head or even less.

The writer has given much study to the question of getting a device which will be simple in construction, positive in operation, flexible enough in construction to be adapted to all conditions met with in practice, and yet be reasonable in cost. The success of the endeavor is attested by four devices which are already installed in different plants and are all giving excellent satisfaction. The number of beds that can be operated is unlimited by the device and contact beds either single or double can be operated with equal ease and simplicity.

In a great majority of the smaller installations, automatic siphons alone can be used to best advantage, and the Pacific Flush Tank Co. are putting upon the market different combinations of siphons, which will fill the wants of the Sanitary Engineer, who has the responsibility of designing plants of this character. Their twin and triple alternating siphons are deserving of attention and the combinations which can be made by their use will bring them into even wider use than their makers realize.

We hear much in favor of the percolating filters, especially in the English publications. The writer is now having his first experience in the construction of one which when this article was promised it was expected would be in operation, and some results of interest could be added. The plant is designed with a capacity of 80,000 gallons of factory sewage per day and consists of a septic tank, followed by upward filtration through a

seven-foot anaerobic filter of hard clinker, the flow is then divided into three small siphon chambers or dosing pits, each holding some 200 gallons and having a six-inch siphon to discharge its contents through a series of distributing troughs over an aerobatic filter; this filter is also composed of broken clinkers seven feet six inches deep, resting upon an inclined cement floor. It has a top surface, area thirty feet by fifty-four feet or 180 square yards. The sides of this filter are open and exposed, and every facility has been afforded us to get the best results.

To me it seems important that we as Engineers, giving special attention to this line of work, should do what we can to educate the public along this line and a few good successful plants properly operated will do more than all the theories we can offer, and I am inclined to believe that these can better be built by some strong Construction Company, who will give bond for their construction and operation, say for two years, than by local contractors, who have never seen plants of this kind, and whose interest is only in the profits to be had in doing the work.

I find so many of the present plants getting into disfavor and bad repute just because they are not properly cared for and operated, that it is in a way discouraging.

A design may be most carefully worked out in every detail, and the plans turned over to a resident Engineer for construction, who in order to economize in construction unwittingly makes small changes, which seriously affect the efficiency of the plant.

FORESTRY IN MICHIGAN.

F. E. SKEELS.

The Michigan Forestry Preserve comprises about forty thousand acres of land located in Roscommon and Crawford Counties. In Roscommon the lands set aside for the Preserve are in the west half of the county, and in the two townships of the east half that lie adjacent to Houghton and Higgins Lakes. The lands in the county of Crawford are located in towns 25 N. 3 and 4 W., lying immediately north of Higgins Lake.

These lands were set aside as tax homestead tracts eight or nine years ago, and about every forty that was of any value for farm or timber purposes was taken by the homesteader. The usual results following the offer of cheap lands to the public, either by the State or the general government, have obtained here, fully forty per cent of the lands being taken for the timber, and abandoned when stripped, or by some State agent who stopped the cutting. A small per cent of these lands have been taken by actual settlers, who evidently intend to make homes. None of the lands in the Preserve were set aside for forestry purposes until they had been exposed to Homestead entry for a period of nearly five years.

The tract embraces the entire country around Houghton and Higgins Lakes, and is therefore the source of several important streams flowing either easterly or westerly to the waters of the Great Lakes. The timber which comprised the original value of these lands was transported through these rivers to Muskegon, Manistee, Au Sable, Oscoda, Bay City, and Saginaw, to be manufactured in the immense lumbering plants which have mostly become items of history. This timber crop was fit for the harvest, and nothing of value was left on the tracts, which were covered with an almost solid pine forest. Naturally enough, when the owners of these tracts saw no further value in the lands their interest waned, taxes were not paid, although unscrupulous assessors forgot not to assess at almost

the same figures of valuation that obtained in well-timbered lands, and the great areas were bid in by the State at the annual tax sales.

Much has been written, and more said, censuring lumbermen for stripping these lands and then abandoning them to the State, but I do not believe any man or class of men would have endured these unjust assessments any more than did these same timber men, and they sought their only safety in letting the property go. In some portions of the Preserve we find fairly good hardwood lands, and much swampy land, either timbered with cedar and spruce or lying in great blue-joint marshes, as are found near the head of the Muskegon River. Most of the successful homesteads are located in these better lands. In fact, we have made a thorough investigation and fail to find a single homesteader who is able to make a living on any lands from which only pine timber was cut.

We wish to state here that the counties of Roscommon and Crawford have many good farms, and much good farming land, but neither the good farms or farming lands are to be found within the limits of the Forestry Preserve. Not all the lands in the area set aside for forestry purposes are stump lands, or lands timbered with anything usually considered of value. Nearly the entire area of several townships has almost no stumps and no timber, except Jack pine and a few scattering Norway pine. None of the early timber cruisers remember having found any timber of value, and the government field notes show all bearings to have been inscribed on "spruce pine," the term used by the surveyors to designate what is now universally known as "Jack pine."

The topography of the country is good. There are no bluffs or steep hills, although almost all the territory originally covered with pine is quite rolling. No attempt at agriculture has been made on much of the stump lands, but many have been deluded into trying to make farms upon the more easily cleared portions of the "Jack pine" plains, especially in portions where the fires have killed and burned off everything in the timber line. Dwellings and barns were constructed, often at a cost of thousands of dollars, fences were built, and roads laid out,

on section lines, making veritable checker boards of the areas; but the players were soon disgusted with the game. The schoolhouse, the farm house, the barn, are used by roving cattle and other stock as they seek to find some sort of shelter, or the buildings are burned down, leaving only the plaster that formed the walls, and the old cellar hole filled with charred timbers, or the rocks that formed the foundation of the building. Everywhere can be seen scattering fence posts, where were once the fences marking the farm boundaries, and occasionally a stunted fruit tree marks the attempt made toward planting an orchard. It is these lands, entirely unfitted for agriculture, and in most instances for grazing, that have been sought for by, and which have been turned over to, the Michigan Forestry Commission.

The timber upon these lands, where it deserves the name, is largely of Jack pine, which in some locations is now large enough to lumber, or of scattering small Norway trees that have survived the fires. Everywhere one finds the young Jack pine thrusting itself up through the moss and sand, and on the better lands young oaks have covered these areas with a growth that would soon become valuable if it were not for the severe burnings, easily verified by a few isolated trees which are now, at an age of twenty-five to thirty years, large enough for railroad ties.

The natural tendency of this land to reproduce a growth of timber is made apparent very strongly on the once-cultivated lands, now abandoned. These old fields, still showing the old plow furrows, with no material that could be burned, have formed most excellent seed beds for the pines, and in many places we find a dense growth of young Norway and Jack pine, showing a strong, thrifty annual growth, and already reaching a height of from ten to twenty feet. It is the purpose of the Forestry Commission to protect these young growths, and to add to them wherever practicable.

The seeds of the Norway and white pine come from the scattering trees left upon the plains, or from the blocks of very fine original pine still standing along the western and northern boundary lines of the Preserve. But the Jack pine is the great reclaimer — small trees five feet in height bear cones filled with

seeds, and any plowing of the land will be immediately followed by a thick growth of "Jacks." This timber was once despised, but is now sought for, and demands and receives the same rating in price as does Norway.

The Forestry Commission, besides protecting the young natural growth, has fenced in and planted two plats of ground on Secs. 35 and 36 of T. 25, N. R. 4 W. One of these plats has been plowed, harrowed, and marked as for corn, and is planted to cuttings of North Carolina poplar, and nuts of walnut and butternut, and seeds of white and Norway pine. The other plat is just as we found it, so far as tilling is concerned, but several thousand cuttings of North Carolina poplar have been planted, as well as several thousand nuts of different sorts. These plantings are of course largely experimental, and were made because of the great success attending the planting of the North Carolina poplar on the very light, sandy soil near Port Huron and other localities in Michigan.

Mr. L. B. Rice, of Port Huron, exhibited at the State Fair, in 1902, excellent boards of this timber, having a width of ten inches for an eight years' growth from planting. Black walnut and butternut grow well, and fruit freely, in Cheboygan and Montgomery Counties, although neither of these trees is found native in either county. The United States Department of Forestry have taken sufficient interest in this Michigan enterprise to send out their experts, who made a careful survey of the situation, examining trees of various species, to ascertain their average annual growth, and the trees best adapted to the soils and climate. Their reports are very favorable to the successful working of the plans proposed by the State Forestry Commission.

The families who are now located in the Preserve should be encouraged to remain. If the plans of the Commission mature, these people will find fair employment in the service of the Preserve, in guarding against fire, planting, fencing, and in the construction of roads. Some fault is found that the Forestry plans will interfere with the raising of stock. So long as stock owners do not own or make any effort to own the lands, but prefer rather to graze their stock on lands which are owned

by the State, thereby getting free feed for their cattle, the industry should not be encouraged. Such business brings no revenue to the State, the county, or to the township. The cattle are purchased in the West, and turned out too late for assessment by the supervisor, and shipped away again in the fall, the entire venture being of profit only to the party or parties who own the stock, and a great nuisance to the few farmers who have to build expensive fences or abandon their crops to the herds of trespassers.

There is another class of people who have objected to the Forestry plans, and they are the fellows who buy up large areas of these tax lands, plat out lots, and sell from elaborately drawn maps in Chicago and other large cities. Each sale made means revenue to the county officials, and thus we find another obstacle offered in the influence exerted by these gentlemen whose official positions make them financially interested in selling the lands.

The present conditions of the lumber and especially of the fuel trade should make the importance of timber growth apparent to every fair-minded individual. The State should be encouraged in this new venture, and the Forestry Commission substantially aided by the influence of the best citizens of our commonwealth.

Mr. Hubbell—Some years ago the United States Bureau of Forestry sent out circulars offering to formulate plans, advise and supervise the care of forest areas. If the plats were small and designed as permanent wood-lots in connection with farms, the plans were prepared and advice given free of cost. If the area were large and designed for lumbering purposes, the plans were to include subsequent personal supervision, and the owner was expected to pay a portion of the cost of the same. Accepting of this offer, considerable tracts of timbered lands have been placed in the hands of the United States Bureau of Forestry, especially in the Adirondack Mountains, in the State of New York. The plans prepared have usually taken the form of dividing the whole area into a considerable number of parcels, or tracts, 20 or more in number. One parcel or tract to

be cut over each year, leaving all trees 8 inches and less in diameter; care also being taken to prevent destructive fires, it being expected that when the last tract had been cut over, the one first cut would be ready for a second cutting, and in this manner the tract as a whole would become a permanent and perpetual source of supply of timber. So far as I know, none of the lumbermen of Michigan have accepted of this proffered aid and assistance by the United States Bureau of Forestry, and the purpose of this report is to state some of the objections which are urged by them for not doing so.

1. The plan is so radically different from their plan of lumbering that they very much dislike to make the change. They are also disposed to look upon the assistance of a Government Forester very much as the commercial fisherman looks upon the assistance of a deputy game warden. His efforts may be of great benefit to the business as a whole, but each individual seriously objects to a personal application to himself. In other words, they are afraid that such assistance and supervision would interfere with the free and independent conduct of their logging business.

2. It will increase the cost of logging. The cost of logging has been brought almost to a fine art, and if a foreman or jobber cannot put out logs within a few cents of the estimated minimum price per thousand feet, it is a matter for investigation. When a tract of timber is about to be cut there must be good roads prepared, camps built and other preparations made, all of which is a charge against the cost of logging, and if only a part of the timber is cut, it will increase the cost per thousand feet. It is in vain to say that these roads and camps can be of use in the future. Before the expiration of 20 years they will be grown up with brush, washed and gullied; the point for the delivery of the logs may be different and the camps will be either rotted down or destroyed by fire. The whole cost of the roads, camps, etc., must be paid for by the logs cut at the first cutting. It is also an extra expense to take care of the brush and save the young standing timber.

3. Restricted output: This restricted output might be a benefit to the business as a whole, but each individual is desirous

that it should apply to others and not to himself. But few lumbermen have sufficient standing timber to last 20 years, it being their plan to cut as fast as they can handle and market the same, and when the present supply is exhausted buy more or move their plant, or quit the business. To take the present holdings, and divide into 20 parcels, and cut only 75 per cent of any one parcel each year would result in very small output for a large number of our present lumbermen.

4. The cost and care of part-cut lands: As soon as timber is purchased it becomes a bill of expense to look after it and see that there is no trespass or destruction by fire. If the timber is only partly cut it cannot be abandoned (as is usually done with clean-cut lands) to take care of itself. Timber depredators are too busy to let it alone, even if it escapes the ravages of fire. To maintain this watch and care for an additional period of 20 years would entail a considerable cost and expense.

5. The danger of loss by fire from the rubbish of the first cutting is very great and very difficult to avoid.

6. The taxation of the part-cut lands is a serious question. As long as a lumberman allows his timber to stand he must do the best he can to avoid excessive taxation, as he cannot abandon his timber and must pay the taxes. When a man has cut his land over clean, he can say to the assessor, "Now, you put that land on the tax-roll at a very low figure or I will neglect to pay the taxes." But if 25 per cent of the timber is left standing, it is sufficient security for the taxes, and he is at the mercy of the assessor and must pay the taxes on that land, no matter how high they are, or lose the timber left standing thereon.

7. Many of the large lumbermen have borrowed the money to invest in timbered lands and are paying interest on the capital so invested. The timber is their raw material. If they leave any considerable portion of it standing, it is doubtful if they can pay back the borrowed money and pay interest, and have any profits left for themselves. They do not like the idea of leaving a part of the timber from which they cannot expect to receive any returns for the next 20 years. Whatever may be the claims made by foresters, or the figures shown by them,

he does not believe that the small timber left standing will increase in value enough to cover taxes and interest on the money invested.

8. The elements are likely to prevent the carrying out of any plan to cut a given piece or parcel of timber in any one specified year. Forest fires not only burn over cut lands, but frequently do great damage to standing timber, making it necessary to cut the same at once in order to save it, which may make necessary a radical change in the entire logging operations for a year or two, and these fires may include part or all of the timber embraced in several yearly parcels or subdivisions.

9. All large and enterprising lumbermen want several camps in readiness for operation each season. Some located on high lands, and some in swamp lands; some accessible to river, and others to railroad transportation. If the winter is cold, the work is pushed in the swamps, and if the sleighing is good they take advantage of it, and put in the logs on the long hauls. If it is an open winter, the swamps must be left until some other winter, and if the sleighing is a failure the short hauls must be used and logs hauled upon big wheels, if necessary. These contingencies, which cannot be foreseen, interfere with any pre-arranged plan to cut certain parcels progressively, or in any one specified year.

10. The representations made that by this plan the business becomes perpetual, furnishing a supply of timber forever, does not appeal to the average lumberman as very desirable. Lumbering is a hard, rough business. He does not care to be everlastingly at it, and is very much in doubt whether his children will thank him for such an inheritance. He prefers to do as large a business as he can, rush it through while about it, cut clean, finish it up and quit. For these reasons it is apparent that the lumbermen of Michigan do not intend voluntarily to adopt the plan of Government Supervision, at least under present conditions, and unless something can be done to remove these objections, we must expect to see the lumbering business of Michigan conducted along the same lines in the future that have been used in the past.

GEOLOGICAL CHANGES NOW GOING ON.

A. C. LANE, STATE GEOLOGIST.

If you look at the second-hand of your watch you can readily see that it is moving, but a casual glance at the hour-hand would lead you to say that was fixed and unchanging. Only by observation, repeated over a length of time, would you convince yourself that this was just as much in motion as the second-hand, only at not so rapid a rate. The same principle applies in studying many of the geological changes. We are inclined to consider the earth as fixed, and streams as relatively permanent, while in fact there are changes continually going on. The rate of change is, however, so slow that it can be measured only by repeated observation at considerable intervals of time. Moreover, we hardly realize how short is the interval during which anything like exact observations have been made. The earliest surveys that can have any claim to exactness are much less than 100 years ago, so that changes which would be only slight during that time would be forty times greater if they continue at the same rate since the time of Abraham.

I want to call your attention to a few different kinds of changes which you are likely to encounter as engineers, and which are rapid enough so that observations of a few decades apart can give us some idea of their rate. I shall not speak of the magnetic variation of the dip needle, because that has been very fully treated on various occasions.

The first case to which I would call your attention is that of the wave cutting, and the wasting of the cliffs along the lake shore. This seems to be most marked on shores facing eastward, so that the west winds and currents tend to carry the material ground up by the waves off shore, and thus prevent its clogging the action. At Port Huron there is a lively controversy regarding the amount of wastage immediately north of the town. Somewhat further north, near the line between

section 18 and section 19, town 10 north, range 17 east, is a fine case of waste of the land, which was investigated for me by Dr. Gordon, who, with the assistance of the County Surveyor, Thomas Nichols, re-surveyed the coast and found the rate of erosion since 1823 to have been 5.7 feet per annum.

A distinct impression of recency in lake encroachment is gained by observing in places plow furrows cutting straight out to and across the edge of the bluff. At one point three distinct stages of cultivation were noted. First, the oldest plow furrows at right angles to the bank extending clear out to the edge, the corresponding north-south furrow having been removed by the waves. Second, outermost furrows parallel with the cliff, and within six feet of the edge, a position it would be impossible to reach by the plow at the present time. Third and last, with the outermost furrow about ten feet from the edge. These stages are all clearly defined, and indicate a distinct encroachment of the lake between each period of cultivation. Opposite the north boundary of this estate at "E," Mr. Papst, who owns the property on the north, has placed a crib of logs which has checked shore wash here, and inaugurated a stage of land building.

The old government road from Port Huron to Port Austin follows the lake shore here originally at a distance of several rods, and shows upon the map of the Lake Survey made in 1858. Well-marked traces of it can be found to where the ruts run off the bank, and on again as shown in the map given in my report for 1901. By comparing these maps of 1858 we find that of the total waste from 1823 to 1901 of 27.25 acres (over a half-mile frontage) about nine were before 1859, and the remainder since. Probably the greater rate of erosion in recent years is due to the removal of the forest protection. We find similar changes recorded at Lexington, and further north at White Rock, where we find indications of an erosion from 3 to 6 feet a year. Sometimes these observations require some skill to interpret in detail, as there may be more or less special protection to the land, or the lake may not have stood at the same height. The lake is lower now than it was along in 1885-6, and has been so ever since 1891, and in consequence there has been

a strip added to the shore in many places, whereas previous to that time there had been very active erosion. Near Harbor Beach a strip of 50 to 100 feet has been added within the last 30 years, and yet on the west line of section 7, town 16 north, range 16 east, there is a loss from the original survey of some 50 links, and on the south line from some 20 to 30 links. This shows that previous to the recent addition of land, that is, during the fifty years from 1835 to 1885, there must have been a cutting of between 100 and 200 feet. A very similar case has been called to my attention by Mr. Sears, and I have touched upon it in the Annual Report for 1902, page 14.

The rate at which the lakes cut away at their rim is, however, affected by another factor. The whole basin of land in which the lakes lie is being tilted, and is rising to the north faster than to the south. Now it is not the easiest thing in the world to prove this matter, for it requires careful and continual gauge reading at various points around the lake, continuous, like something over a year, or, at the least, every day for more than a month, and repeated after the lapse of some decades. If, for instance, we have a gauge referred to "A" bench mark at the south end of the lake, and we find that in the year 1850 for the month of August the average water level was 2.1 feet, and the year 1900 2.2 feet, and if at another point much further north we have another gauging station "E" referred to the bench mark "D," and the elevation of that bench mark was in 1850 3.1 feet above the lake, then in 1900 if the lake is level, and there has been no tilting, the point "D" will be 3.2 feet above the level of the lake; but if it has been rising, then the point "D" will be more than 3.2 feet above the level of the lake. Now Mr. G. K. Gilbert has found by careful comparison of the old lake survey gaugings with some that he had made five years ago expressly for the purpose, that there has been such a tilting; that this tilting is not a temporary tilting is shown by its geological effect. The streams south of the line running from Port Huron to Menominee come into the lake as dead water. They are, as we often say, drowned. North of that line they rush into the lake, and have good water powers near their mouth. In the one case, the water has been receding

from them, and in the other case, backing up into them, but we have as yet by no means as much data as we desire in this matter. If anywhere near Alpena, Cheboygan, Mackinaw, or Old Fort Drummond we could find records showing the elevation of some bench mark which we could now determine above the water level years ago, it would be well worth while to arrange to have another gauge set, and see what its relation to the water level is at present, and how much it had risen relatively to points nearer the south end of the lakes.

Another kind of geological change is the filling in of the lakes. That is very noticeable in Lake St. Clair. The St. Clair Delta was, so far as I know, first surveyed under Captain Bayfield, of the British Navy, but has been surveyed at several intervals since, up to the last and complete survey by Prof. J. B. Davis. Now while Prof. Davis has told us it is extremely difficult to draw the line between land and water down there, I think we shall be able to obtain some interesting results. There are, however, numerous small lakes which are filling up, and I have great hopes that after a few years we can take some of these which have recently been very carefully surveyed for their marl deposits, and by re-survey determine the growth of such deposits, and the rate of filling of the lake.

The streams are also meandering in their valleys, cutting here and filling there. Once in a great while, as at the Titabawassee bridge at Freeland, we are able to get some definite figures as to the rate of erosion, but usually it is quite difficult. Now my main object in writing this paper is to call your attention to such changes as I have described, and to urge upon you that whenever you run across records of accurate surveys or gaugings, etc., which if repeated might give us some indications of the rate of these changes, that you correspond with the State Survey and have the facts put on record. Sometime, perhaps in many cases now, it may be worth our while to do some re-surveying to determine the rate of change.

SOME REMARKS ON WATER LEVELS.

CHAS. M. DIXON.

The fluctuations of the water levels of the Great Lakes and their connecting waters due to the action of storms, has always been a source of much expense and trouble to vessel owners and vessel captains. The carrying capacity of vessels is usually regulated by the safe draft at the place of least depth in the channel through which they are to pass, and the result is costly to the vessel interests when the place of least depth is also so situated that the fluctuations due to storms is great. When deeply laden vessels arrive at the place of least depth at a time when there is a low stage of water, they either anchor and wait for a higher stage of water, or at times they take their chance of getting over safely, and then usually make repairs later.

It is the intention to state briefly, in this paper, the conditions which have prevailed on the Detroit River for a number of years, and to suggest some means of improvement.

At the present time, and for the past several years, the place of least depth in the channel connecting the upper lakes with Lake Erie is, and has been, at the Lime Kiln Crossing in the Detroit River. The channel at this place has been dredged through a ledge of limestone, and the bottom of the river is studded with sharp-pointed pieces of bedrock which seem to have been intended to do damage to any vessel coming in contact with them. Also at this place, the fluctuations in the water surface due to the effect of storms is very great.

As the slope in the river between the Lime Kiln Crossing and Lake Erie is, under normal conditions, only about 0.5 feet, there is nearly the same fluctuation at Lime Kiln Crossing as at the westerly end of Lake Erie. High water at this place is caused by easterly winds, and low water by westerly winds. The greatest change in the elevation of the water surface during any one storm of which there is record, was on Sept. 12, 1900, when the extreme range was about 6.0 feet,—the length of time between extreme high and low waters being 9 hours.

A fluctuation of 3.0 feet during a moderate gale is not infrequent, however, and this fluctuation may occur in a period of from three to four hours, or at the rate of about one foot per hour.

The present least depth at Lime Kiln Crossing at the normal midsummer stage for the season of 1902 (high water stage) is about 19 feet. Contracts are in force and provided for, however, under which it is intended to secure a depth of 21 feet at a low water stage (being 1.8 feet lower than the high water stage). Although at a normal midsummer stage of water there is a present clear depth of about 19.0 feet, the actual depth frequently varies from 18.5 to 19.5 feet, during a period of 24 hours,— this on account of only moderate winds. The fluctuations during the late fall months is much greater than during the summer months, on account of the greater frequency of strong winds.

When it is remembered that vessels are loaded to the full draft permissible at this place, it will be apparent that it is extremely desirable that the captains of approaching vessels be accurately informed as to the depth of water, and this before they have passed the last convenient anchoring ground. During the past several years, this information has been furnished to vessel captains by private parties who, when the stage of water is below the normal, telephone to two places (one on each side of the river just below Detroit) the safe draft for vessels whenever there is a change of one inch in the stage of water. This information is then posted in large figures which may be distinctly seen for one-quarter of a mile, to be read by the captains of passing vessels. The service thus rendered has been quite efficient and very beneficial to the interests of navigation. The cost of maintaining this service has been paid for by the Lake Carriers' Association representing the vessel interests.

Although it is the intention to still further improve this channel, no matter to what depth this improvement may go, vessels will still be loaded to the limiting depth, and the water surface will still continue to fluctuate. There will, therefore, always be a demand for the furnishing of information to vessel captains

regarding the depth of water. This being a permanent necessity, it has been deemed as important that the government should supply this information, as that they should establish and maintain lighthouses and other aids to navigation.

For this reason, I was directed, during the summer of 1901, to obtain data regarding the fluctuations of the water levels at the mouth of the Detroit River, with the view to devising an improvement in the present method of furnishing this information. It was believed that, under the same conditions as to weather and stage of water, the elevation of the water surface at or near Detroit was a constant function of the elevation of the water surface at the mouth of the river. Therefore, should simultaneous water gauge readings be taken at these places covering all conditions of weather and all the varying stages of water, it was believed that the stage of water at the mouth of the river could be accurately predicted knowing the stage of water at Detroit. Such simultaneous readings were taken at Sandwich (3 miles below Detroit) and at Amherstburg (near the mouth of the river) during the period from June 15 to Dec. 15, 1901. From these observations, it was found that, during this time, the slope in the river between these points varied from 1.0 feet to 3.2 feet, with a mean of 2.2 feet. The results of these observations are plotted on the chart, which indicates quite clearly to the eye the changes in the slope during the period of storms.

Although the results of these observations did not disprove the statement that the function involving the elevations of the water surfaces at these two places is constant under certain fixed conditions, they do show quite clearly that trouble might be expected when it came to "fix the conditions." It is believed that, using the stage of water at or near Detroit as a basis, the stage of water at the Lime Kiln Crossing cannot be predicted with certainty to less than 3 inches of the actual depth. When it is remembered that, under the present conditions, vessels pass with safety, almost daily, when it is known to the captain that there is not more than one inch between the bottom of the vessel and the jagged points of rock, it is clear

that a method by which a prediction cannot be made more closely than 3 inches will not suffice.

It was clear, therefore, that no improvement could be made on the present efficient method of furnishing information as to depth of water, unless some device could be perfected for displaying signals at or near Detroit, the action which device would be automatic in its nature and be controlled by the changes in the water surface at the place of least depth. During the fall of 1901 and spring of 1902, I endeavored to perfect such a device, and after the expenditure of considerable time and money I found the result to be unsatisfactory on account of mechanical errors. I then made the acquaintance of Mr. Alvah T. Hill, of Detroit, whom I succeeded in getting interested in this problem, and he consented to help me out of my difficulty. The result is the device in its present condition, which was for more than a month in successful operation, and during that time it was never found in error until the power of the battery cells was expended. The distance through which the electric current was transmitted was only about ten feet, but the device would do its work as perfectly at a distance of 100 miles, the only difference being the amount of battery power required. It is believed that this device is about as perfect for the object intended as it can be made, and the credit for this is entirely due to Mr. Hill.

This device consists essentially of a dial, similar to the hand of a clock, the movement of which over a graduated arc, is controlled by the movement of a float at the place of least depth in the channel by the making of an electric contact at equal intervals of change in the elevation of the water surfaces. The dial and graduated arc are to be erected at any place along shore where it is desired to display the water gauge signals, the mechanism at the dial and at the float to be connected by three wires, one for forward motion, one for backward motion, and one for the return wire. The battery power required to operate this device is not much greater than that required to operate a telegraph instrument. Any number of dials may be distributed along the river and all operated from the same float,— this, by having the mechanism at each dial act as a relay to complete

the circuit from a local battery operating the next dial. With such a scheme as this in successful operation, one or more dials being located at convenient points, vessel captains may look ashore when passing and see the safe draft for vessels, just as they would get the time of day from the town clock.

This device, with slight modifications, may also be adapted to the transmission of similar information concerning the pressure indicated by a steam gauge, the height of mercury in the thermometer, in fact, anything that fluctuates.

A DESCRIPTION OF THE PLANT, AND OF THE METHODS EMPLOYED IN THE DEEPENING OF THE CHANNELS OF THE GREAT LAKES AND THEIR CONNECTING WATERS.

HARRY HODGMAN.

In preparing this paper I have concluded that the most compact form of expressing the information will be the most acceptable to those who care to seek for information therein. I have, therefore, tabulated the information so far as possible, rather than writing long individual descriptions.

As drilling and blasting are often necessary before dredging can be done, I will first describe the machinery, and the methods used in doing this part of the work.

Prior to 1865, very little submarine drilling was done on the Great Lakes. Dunbar and Sullivan, who were pioneers in that class of contracting, describe their first plant as consisting of a small raft, or float, operated by four or five men, who anchored it in position for work, and then drilled the holes by churning a long chisel-pointed iron bar up and down until the hole was of the proper depth. Then a tin can filled with black powder, and having attached to it a slender tube of sufficient length to reach from the bottom of the hole to a point above the water surface, was inserted in the hole. The powder was then exploded by dropping a red hot nail upon it from the top of the tube.

The drill boats of to-day have hulls of a minimum size of, length 60 feet, width 24 feet, depth 5 feet. They are equipped with three or more steam churn drills of the Ingersoll or similar pattern, which are operated on vertical frames having trucks which permit of their being moved horizontally along the edge of the boat, and between which the drill bar and drill are raised or lowered, as required, by a hydraulic lift. The drill and the hydraulic are connected with the boiler and pump respectively by flexible pipes. The boat is provided with a boiler of suffi-

cient size to furnish steam for the drills, for the pumps used in connection with the hydraulics, and for operating the forge and the electric light plant, with which nearly all drill boats are provided. Spuds are placed at each corner of the boat and serve to hold it in position, this being insured by making each spud bear a portion of the weight of the boat, or as it is called, "pinning up" on the spuds. These spuds are usually about a foot square, and are raised and lowered by steam.

In the accompanying tables will be found the dimensions and efficiency of a few drills which have been operated on the Detroit River during the past three years.

In limestone, such as occurs in the Detroit River and vicinity, it is customary to drill holes at the corners of five-foot squares ,and to use about one pound of sixty-per-cent dynamite per linear foot of drilling for blasting the rock. The holes are drilled to a depth of two or three feet below the grade plane to insure the required depth.

To charge the holes, the exploders are attached to the wires of a battery and secured to the sticks of dynamite; the latter is then placed within the bottom of a long tube which has been enlarged at its lower end to a diameter and length sufficient to admit them, the battery wires leading out through a longitudinal slot in the pipe. The pipe is then lowered into the drill hole and the dynamite shoved into its place by a long ram rod. The pipe and rod are then removed and the dynamite exploded.

In deep water drilling, such as occurs in our ship channels, the boat is never moved on account of blasting. To one unaccustomed to such work, this would seem quite dangerous; but such is not the case. The greatest danger in connection with it is that in a strong current the dynamite may float out of the hole and be exploded at the bottom of the boat. This danger is mainly overcome by placing a ring with wire prongs around the cartridge before putting it in the hole, the ends of the wires pressing against the perimeter of the hole, holds the dynamite in place. Accidents from the above-mentioned cause do, however, occasionally occur, as two drill boats were sunk from this cause within a year on the Detroit River.

TABLE No. 1
COMPARATIVE DIMENSIONS OF DRILL BOATS.

Name of Boat.	Name of owner.	Dimensions of Hull Length ft.	Width ft.	Depth ft.	No of Drills	No of Hydraulics	Description of pump	Description of boiler	Remarks.
Dynamiter	M. Sullivan, Detroit	60	24	5	3	3.	Worthington pressure pump 12½x12 size	7'x12' (Return fire box).	
No. 2.	" " "	95	26	6	3	3	" " " " "	8½'x14' "	This boat has boiler capacity for 5 drills.
Erie.	Jas. Donnelly, Buffalo	75	28	5	3	3	" " " "	6x12' "	Boiler capacity is insufficient
No 2.	" " "	70	27	6	3	3	Snow steam pump 12x5x12	7x12 "	
No. 1	Buffalo Dredging Co.	80	26	5½	3	3			

TABLE No. 2
COMPARISON OF ACTUAL WORK DONE BY DRILL BOATS.

Name of Boat.	Name of owner	No. Hours Worked	No. Holes Drilled	No. Linear feet Drilled.	No pounds of Dynamite used.	Coal consumed Tons.	Material Drilled	Location
Dynamiter	M. Sullivan.	7683	23000	112000	155000	2400	Limestone	Amherstburg Reach, Detroit River, Mich
No. 2.	"	1000	2170	11100	18450	2400	" "	" " " " "
No. 2	Jas. Donnelly.	1137	2638	18100	19450	300	" "	" " " " "
No 2	" "	4127	6334	61513	58825	999	" "	Lime Kiln Crossing, " " "
Erie	" "	9145	22196	174087	158671	2485	" "	" " " " "
No 1.	Buffalo Dredg. Co.	4522	30000	89000	33000	1150	Limestone, boulders & hardpan	Ballard's Reef Channel, " "

Drills are usually operated day and night by men working in shifts of twelve hours. The number of men required on each shift to operate a boat having three drills is about eleven. The cost of operating such an one continuously is about three thousand dollars per month.

DREDGES. The most of the dredges now in use on the lakes are of the dipper variety. I know of but five or six hydraulic, and but one clam shell, dredges being in use on the channel improvements of the Great Lakes.

The most of the dredges now in use on the lakes are of the dipper variety. I know of but five or six hydraulic, and but one clam shell, dredges being in use on the channel improvements of the Great Lakes.

I regret that I am unable to give you much information regarding hydraulic dredges, as they will undoubtedly be more extensively used in the near future. I have been told that there are two very good ones now in use on the improvement of Duluth harbor, and that a Cleveland firm has one in process of construction which they expect will have a capacity of about sixty thousand cubic yards in twenty-four hours in favorable material. The Russian government owns one which will excavate seven thousand cubic yards per hour. The United States owns and operates some very fine dredges of this type on the Mississippi River, and they are in common use on our sea coasts. The Canadian government has recently constructed some excellent ones, which I expected to describe in this paper, but the information I desired reached me too late.

Tables 3 and 4 show comparative dimensions of a few of the dipper dredges, and the actual work done by them. The tables were not made as extensive as desired, owing to lack of time and difficulty in securing information.

These dredges have three spuds,—a trailing spud at the stern, and two upright spuds at the bow used to "pin up" on, and which are raised when the dredge moves ahead. These spuds serve to hold the dredge in position while working, and are usually from twenty to thirty-six inches square. They are

TABLE No. 4.

SHOWING ACTUAL WORK DONE BY DIPPER DREDGES.

Name of Dredge	Name of Owner	Time Worked Hours	Time Delayed Hours	Amt Excavated Cub. Yds Scow Measure	Face of Excavation	Approx Amt Coal used per day tons.	Character of Material
Napoleon	Duluth Dredge and Dock Co.	1181	435	477171	20 to 30'	7	Clay and sand.
Breymann No. 1	G.H. Breymann, Toledo	1149	248	477769	20 to 30'	7	" " "
Pan American	Lake Erie Dredging Co	849	455	234440	10 to 20'	7	Clay, gravel, & stones.
Breymann No. 3	G.H. Breymann, Toledo	957	65	73155	6'	3½	1000 cub yds. lime stone, remainder sand, clay, and boulders.
Gladiator	M Sullivan, Detroit	800	125	27445	3'	3	11000 " " " " " " " " " " "
No 5	W.S Carkin, Detroit	3600	1400	163½77	9'	3½	Blasted lime stone.
Brian Boru	M Sullivan, Detroit.	2500	735	54508	3'	3	23000 cub yds blasted lime stone, remainder, clay and boulders.
Old Glory	" "	3300	1190	70598	3'	3	39000 " " " " " " " " " " "
No. 1	Buffalo Dredging Co.	2550	1270	72102	3	3	33000 " " " " " " " " " " "

TABLE 3.

COMPARATIVE DIMENSIONS OF Dipper Dredges

Name	Dimensions of Hull	Length of Boom. Ft.	Depth of Digging. Ft.	Capacity of Dipper. Cu Yds.	Main Engines	Forward Spud Engines	Backing Engines	Swinging Engines	Boiler	Hoisting Drum.	Hoisting Gearing	Rear Spud Engines	Circle	Cable or Chain	Pull on Bail Pounds
* Daly No 1	40'x115'x12'	48	25	6	2, 16"x18"	Main Eng.	2, 10"x14"	2, 9"x12"	11'x11'	42" and 64"	1 to 17½	2, 8"x8"	18'	2½"	169,000.
* Buffalo	40'x110'x12'x13'	56	40	6	2, 16"x18"	2, 10"x14"	2, 10"x14"	2, 10"x14"	2, 7'x13'	42" and 64"	1 to 17½	2, 10"x14"	19'	2½"	169,000
Napoleon	40'x125'x11'x13'	48	30	7	2, 16"x18"	2, 10"x14"	2, 10"x14"	2, 10"x14"	8'x14'	42" and 64"	1 to 17½	2, 8"x8"	19'	2½"	169,000.
Gladiator	38'x105'x12'	48	27	4½	2, 16"x18"	Main Eng.	2, 9"x12"	2, 9"x12"	9½x10'	42 and 64"	1 to 17½	2, 8"x8"	18'	2¼"	169,000.
Pan American	44'x135'x10½ and 13'	50	25	8	2, 18"x24"	" "	2, 12"x16"	2, 9"x12"	2, 7'x10'	55" and 84"	1 to 13 8	2, cylinders	20'	2¾"	174,000
Breymann No 2	34'x95'x9½ and 12'	48	25	6	2, 16"x18"	Steam Cylin.	Main Eng.	2, 9"x12"	7'x19½'	36" and 47"	1 to 5	Steam cylinder	18'	⅞ chain	170,000.
Carkins No 5	32'x105'x12'	42	25	3	1 Vert 22½"x18"	— —	" "	2, 9"x12"	- - - -	30"	1 to 4		16	1⅝ "	
Brian Boru	28'x96'x8½'	Crane	42	3	2, 12"x14"	Main Eng	Weight	2, 8"x12"	5½x10	42 and 64	1 to 14		14'	2¼"	90,000
Old Glory	80x30'x12'	"	25	3	Comp. 16"x30"x18"	" "	Main Eng.	2, 10"x12"	6'x12'	30"	1 to 4		16	1⅜ ch.	

* By courtesy of The Bucyrus Co.

raised by steam, and the dredge is "pinned up" on them either by lifting it directly by means of cables running over the spuds and through sheaves to drums geared onto the main engines (or to special engines), or by rocking it up by swinging the dipper from one side to the other of the dredge and thus raising the hull one side at a time.

These dredges are provided with hoisting, swinging, and backing engines and drums, and the requisite chains for connecting them with dipper and crane or boom. The backing engine is often dispensed with by gearing the backing drum to the main hoisting drum. These engines and drums are controlled by levers connected to their respective valves and frictions, thus enabling the engineer to operate them.

The dipper of a dredge is hoisted by a cable or chain connecting its bail with the hoisting drum, which is geared to the main engine. The dipper arm is provided with racking and works up or down through a carriage and over a pinion on the boom or crane. The movement of this pinion, and consequently of the dipper arm, is controlled by a friction wheel and belt, the actions of which are regulated by the cranesman, who is thus able to place and hold the dipper at the requisite depth. The dippers used vary in size from two to eight cubic yards' capacity. They have doors at the bottom which are held closed by a latch having a long line attached to it by means of which the cranesman may release it and dump the load,— the door being closed again by the force of the dipper striking the water in its descent. The dipper is pulled back by means of the backing chain. The dredge is pulled ahead in a similar manner by dropping the dipper on the bottom and pulling on the same chain after having first raised the two forward spuds.

These dredges excavate the material by working over the area to be improved in successive longitudinal cuts which vary in width from one-half that of the dredge in rock work, to nearly its full width in soft material containing no large stones of boulders. They will remove from one to three dippers per minute in favorable material.

The material excavated is deposited in dump scows with pockets having doors in the bottom, which permit of the mate-

rial being almost instantly dumped when it has been towed to the dumping ground. The scows used vary in size from those having a capacity of one hundred cubic yards, used by the smaller dredges in rock work, to those having seven hundred or more cubic yards capacity used by the larger dredges in soft material.

The number of men required to operate a dredge is about as follows: One captain or first engineer, one second engineer, one fireman, two deckhands, one blacksmith, one watchman, two scow men, and a cook.

The crews live aboard the dredges, and are usually well fed, and on the newer dredges well housed. In fact, the cuisine on some of the dredges is equal to that of a good hotel. Many of the newer dredges have bath rooms and closets, and rooms provided with hot and cold water, electric lights, and steam heaters. There are, however, few dredge beds that have not more occupants than are agreeable.

The expense of operating a dredge twelve hours per day for a month is about two thousand five hundred dollars, which includes the service of one tug. On work where one tug is sufficient the cost of operating a large dredge is but little more than that of operating a smaller one.

Table five gives the dimensions of some of the dredge tugs that have been in recent use on the Detroit River, and will give you some idea of the service required.

Derrick Scows are used in conjunction with a diver in removing stones, boulders, and similar obstructions from the channel bottom. Those in use on the Detroit River are similarly constructed, being flat-bottomed scows having a length of about seventy-five feet, a width of about twenty-two feet, and a depth of about six and a half feet. They will safely carry a load of from eighty to one hundred tons.

They are provided with the ordinary form of hoisting engines in common use on engineering works, having double engines with cylinders about six by twelve inches, two hoisting drums and winches, a derrick, and a diving outfit. The derricks will handily lift and put on deck a ten ton stone. Stones or

TABLE No. 5.

SHOWING DIMENSIONS OF DREDGE TUGS.

Name of Tug	Name of Owner	Dimensions of Hull			Dimen. of Boiler	Engine	Steam pres. allowed	Coal consumed daily. Tons.	Remarks.
		Length	Beam	Draught					
John Johnson	James Rooney, Toledo	85 ft.	17 ft.	9 ft	8' X 12'	20" x 22"	120#	4	Used with Breymann's No. 3. Dredge in 1902
Columbia	M. Sullivan, Detroit	97 "	20 "	10 "	10' X 12'	16" x 34½" x 78"	150#	4	" " Sullivan's dredge Gladiator
Shaugraun	" "	65	15	8	8' X 10'	18" X 22"	120#	3½	" " " " Brian Boru.
Pauline		65 "	14	8 "	6½' x 10'	16" X 18"	125#	3	" " " " Old Glory.

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TABLE No. 6

SHOWING ACTUAL WORK DONE BY DERRICK SCOWS AND DIVERS IN REMOVING BOULDERS ETC. FROM BOTTOM OF CHANNEL.

Name	Name of Owner.	No. of Hours Worked	No. Cub. Yds. Removed	Locality.	Remarks.
No. 2.	L. P. and J. A. Smith. Clevld.	1815	1346	Ballard's Reef, Detroit River	Working over areas previously dredged.
No. 4	Buffalo Dredging Co.	670	444	" " " "	" " " " redredged by clamshell.
No. 2	M Sullivan, Detroit	114	106	" " " "	Working over areas previously dredged.
No. 1	" "	1460	2493	Amherstburg Reach	" " " " "
No. 2	" "	483	427	" " " "	" " " " "
No. 1	Jas. Donnelly, Buffalo	181	159	Lime Kiln Crossing	" " " " "
No 1	" "	144	224	" " " "	" " " " "

boulders weighing more than that are raised nearly to the surface of the water and then the scow and stone are towed to the dumping ground. Some of these scows are provided with a pump and jet for washing the earth from around imbedded boulders so that the diver may chain them.

They all have a long iron bar suspended from one side to the depth required for the completion of the channel. The scow is hauled back and forth across the channel by means of kedge anchors and lines leading to the winches until the bar strikes an obstruction, when the two spuds, with which each is equipped, are dropped on the bottom to hold the scow in position while the diver chains the boulder and it is hoisted on deck by the derrick.

The coal consumed by a derrick scow is about one-half a ton per day.

The number of men required to operate it is about nine, and the total expense per day, including ten dollars for diver and twenty-five dollars for tug service, is about fifty dollars. Dredging and derrick scow work are usually carried on conjointly, and the derrick is attended by one of the tugs used by the dredging fleet, thus reducing the expense for tug service.

Table number six shows the output of the derrick scows used on the Detroit River during the season of 1902. The work referred to was done in a current having a velocity of two to three miles per hour, which increased the difficulties of the work.

It is difficult to make just comparisons of the work done by different scows, as one may be working in deep water where it may be rapidly loaded with large stones or boulders, while another may be working in shoaler water where there is an abundance of material of a smaller size with which a scow could be loaded only at the expense of a considerable time.

Before any portion of the channel is reported as complete, it is examined by the engineer in charge by means of a sweeping scow or raft having bars suspended to the required depth, which is hauled back and forth across the channel until the entire area has been examined. If no obstructions are found, the work is accepted and the channel opened for navigation.

NOTES OF LITIGATION ON THE TITLE OF A MEXICAN LAND GRANT.

C. A. ENSIGN.

I have been asked to give some notes of a case at law, where contention in the lower court involved the sufficiency of the U. S. patent survey, and where the attack asserted a variance in the description thereof from that of the former government grantor. While the student of history and law will find much of interest and, no doubt, profitable suggestion in the study of the conditions, customs, forms and procedure relating to estates in the country acquired from Mexico, it is presumed the scope of the conferences and subjects of this Society does not invite any attempt here to make such account.

Pursuant to the stipulations of the "Treaty of Peace, Friendship," etc., between the United States and Mexico, made at Guadalupe Hidalgo, Feb. 21, 1848, and probably exacted under the precepts of international law as well, an Act of Congress was approved, 3d day of March, 1851, appointing a Board of (Land) Commissioners, to ascertain and settle the private claims arising by virtue of grants made by the governments of Spain and Mexico. Among others, one Eulogio de Celis brought forward proofs of his right and title to the "Rancho Mission de San Fernando." Relying on the deed of the former governor of the Californias, Pio Pico, and his testimony, on the 3d of July, 1855, the Commissioners confirmed fourteen square leagues to Celis, as the "Rancho *Ex* Mission de San Fernando." The Mexican deed described the land as follows: "Bounded . . . on the north by the rancho of San Francisco; on the west by the mountains of Santa Susanna; on the east by the rancho of Miguel Triumfo; and on the south by the mountains of Portesuelo, which tract is supposed to contain fourteen square leagues."

The General Land Office of the United States thereupon caused a more explicit survey and definite location than the "designs" of Celis' deed of sale, committing the field work to Henry Hancock, a noted surveyor at Los Angeles, as U. S. Deputy Surveyor. Dates show the principal work of the survey was done in 1858. Proceedings were had in U. S. Court to amend course or boundary No. 1, in behalf of the claimant of an adjoin-

ing grant, which was "done in open court, 14 Aug., 1865." The Surveyor General's approval of the final survey dates Jan. 21, 1871.

Dep. Hancock was a competent and industrious surveyor, but it is shown that this work was committed to one of his several compassmen. The dates of quite a number of surveys of large grants at considerable distances apart show that they were proceeding at the same time as under the hand of Major Hancock. He, no doubt, was amply busy in supplying his many camps and "working up his field notes and returns" at his office in Los Angeles. The nearest point to the San Fernando was ten, and the farthest point not less than thirty, miles away. The compassman in charge here was technically incompetent, or, as tradition gives it, rather, kept himself fuddled, resulting in gross mistakes and "fudging" of the returns.

De Celis had disposed of an undivided half interest, and died, and before the surveys of Hancock were approved, an order of the local court issued for a partition, and Wm. P. Reynolds was appointed the surveyor in the proceedings. He was instructed by the Commissioners to proceed without waiting for the "official field notes." To enable the Commissioners to value the property, he run the land into "sections as is done in U. S. surveys," as well as fully retraced the exterior boundaries as run by Hancock, whose notes he appears to have had. Reynolds made his report March 24, 1871, having begun work the previous December. Hancock's survey had been made only about thirteen years before and should therefore have been easily retraced. The "San Francisco Farm and Homestead Association," at the hands of the partition commissioners, were given title and possession to the south half of the rancho, divided on the sectional lines run one mile north of the parallels (boundaries) between T.'s 1 and 2 N. This association later was reincorporated as the "Los Angeles Farming and Milling Co.," which still owns the bulk of the land assigned to them, on which the owners have raised for a long period a considerable annual crop of fine wheat.

In 1888, several "settlers" squatted upon the west border of the ranch. Some of the boundary marks had become obscured, the courses given in the old survey were grossly erratic, and the situation of certain boundaries reasonably questioned, especially as there were traditions that the earlier ranch occupancy did not lie so far west as now claimed. The writer was

employed to ascertain the original bounds of the patent on the west end of the premises and to conspicuously mark the lines with frequent posts sighting each other over the rolling ground of this border; and the "land hunters" without ado withdrew.

About 1891, one Grove, an abstract title clerk, who claimed to have evidence from Mexico and eminent legal assurance, perfected an organization or "association," with considerable funds, to maintain that the titles of the rancho were invalid, and to take possession of the rancho S. F. as homesteaders of public lands in settlements of quarter sections. During the summer and fall of 1891 upward of a hundred quarter sections in the Milling Co.'s domain were appropriated by occupancy with shanties and families in tents. The U. S. Land Office at Los Angeles, however, refused to accept the tender of entry filings. The north one half of the original rancho had been sold and resold, and more or less subdivided and passed to smaller and "innocent" holders. It was farther away from the city. It was less attacked. However, the locations thereon were limited, it is presumed, partly by being promptly met by suits for trespass in the justice courts, the "shanties" at once torn down, and "hauled away for kindling wood."

The managers of the south one half of the rancho, always confident of their rights and integrity, however, reasoned it were more prudent to meet the array of popular belief of a class superficial in knowledge, and reckless, backed as they were by wiseacres of the law, by sueing in the county court. Although the south lines of the rancho patent, that had been disputed at the outset of these settlements in 1891, had been duly ascertained and conspicuously marked, it was deemed expedient under judicial rulings of this State, to retrace the entire boundaries of the rancho as part of the preparation for trial, and in order to doubly assure the testimony to be derived from it, Messrs. Wright and Nicholson were engaged as associates of Mr. Ensign on the complete survey. The exterior lines are forty-four in number, a perimeter of nearly sixty-one miles.

The field notes of Hancock, Reynolds and Ensign are given in succession for each boundary, to facilitate comparison of differences; many abbreviations and ellipses are here used, which we trust will not impair the obvious sense.

Station 1, the point of beginning in the patent (Hancock) survey, was already station 4 of the Ro. Providencia, as surveyed by G. H. Thompson, whose notes had been adopted by Hancock, after an appeal to U. S. District Court to amend the

line first located by him. The corner here was found well preserved. We note Mag. Va. by Hancock (probably from Thompson's notes), 14° 15′ E.; Reynolds, 14° 50′ E.; Ensign, 14° 25′ E., the latter by Obs. Polaris, Feb. 26, 1892, with transit, Young maker, Philadelphia. Hancock, at Sta. 2, gives Va., 13° 30′ E., which seems to have been the Va. adopted by him. Hancock's first course gives N. 20° 30′ W. dist. 210.68 chs. Reynolds the same, but he indicates that he adopts Hancock's courses and distances when variance is within that "admissible in law." Ensign (sighting Sta. 2, and by angle with brg. of Polaris) runs N. 19° 37′ W. 211.86 chs., to Sta. 2, given by H. and R. as a live oak 36 ins. diam. marked S. F. 2 & P. No. 3 (N. W. cor. Providencia Ro.). We found the stump of such a tree cut below old marks. There could be no mistake as to the identity of the corner, as no other such tree had ever stood in this vicinity.

(H. & R.) Thence N. 8° W.

(H.) 393 chs. cors. Ros. San Rafael and Tujungas; and 627 chs. to Sta. 3.

(R.) 338 chs. S. W. cor. Ro. Tujunga and 622 chs to rock m'd. (Sta. 3).

(E.) Thence (by Verniers from backsights) N. 7° 07′ W. 270.22 proportional dist. for partition cor. H. & H. 2 (by Reynolds; no marks found), 386.42 chs. fall 32 links E. of mon. long held as Sta. (14) in bdy. Ro. Tujunga. True brg. N. 7° 10′ W. 386.46 chs. Continuing thence in W. bdy. Ro. Tujunga, corrected course N. 7° 26′ W. and 232.69 chs., making the whole distance between stations 2 and 3 of the patent 619.11 chs. to reddish granite stone faintly marked S. F. 3, in a mound of stone. H. gives a post for cor. and two brg. trees.

(R.) found a mound of stones — and marked a red granite rock and noted bearings corresponding to H.'s record, except the trees were considerably larger. A Mr. Keagel tells us this is the stone he saw Reynolds' man put in its place. We were unable to find any undoubted remains of the witness trees. This corner is on the bank of "Little Tujunga Cañon" — in which the trees probably stood, and must have been torn away by a mountain torrent. We find a post standing N. 66° 38′ W., 20 links dist., set a few years ago as a replacement of this corner by Friel by reference to the ranch house at considerable distance, as observed and noted by Hancock in his survey of the Ro.

Tujunga for patent. Mr. Friel appears not to have discovered the "red granite rock." We reset this rock, rebuilt the mound and covered with earth and dug pits on Ro. lines for the true corner. A portion of the measurement of last line was made, over hills, by careful triangulations.

(H. & R.) Thence S. 81° W. 10.50 chs. to stake.
" " N. 82° 30′ W. 21.50 chs. to stake.
" " N. 74° 30′ W. 64.00 chs. to stake.
" " S. 82° W. 3.76 chs. Int. Ranges 14 and 15 at 1.77 N. of ¼ sec. cor. sect. 6. We found a series of posts lately set by Dep. Ruxon as cors. on a U. S. survey of abutting lands (survey not accepted), which we note as follows:

(E.) S. 81° 22′ W. 11.55 post marked for. Sta. 4 S. F.
" N. 82° 04′ W. 21.55 post marked for. Sta. 5 S. F.
" N. 74° 07′ W. 64.00 post marked for. Sta. 6 S. F.
" S. 82° 22′ W. 3.73 post marked for. Int. Range line, from which an old post marked for. ¼ S. bet. Secs. 1 and 6 T.'s 2 N. R.'s 14 and 15 W. brs. S. 0° 03′ W. 1.77 agreeing with notes of patent and partition surveys.

We observe that the last two posts (in the Range line) are old posts standing in good mounds of strong soil, with pits still visible. The ground about them has never been plowed. If the mounds have ever been enlarged and pits remade, it has undoubtedly been done upon a clear showing of original points. We therefore hold the intersection post found as a true point in the original patent bdy. of the Ro. S. F.

(H.) Course 6 S. 82° W. (total) dist. 49.50 to stake (for Sta. 7)

(R.) Same,—set elder stake in rock mound in middle of old road brg. S. 65° E.; a forked box elder brs. S. 78¾° E. 1. 82 chs. We found the box elder tree, but all marks thereon are now illegible, from which, at N. 78¾° W., 1. 82 chs. in a m'nd earth and stones in the middle of old road we set a granite stone, etc., whence we return and re-establish Sta. 6, by alignment of Int. post and Sta. 7 at 3.76 Easterly. We estimate the proportionate courses from Sta. 3 to Sta. 6 to be

(E.) S. 81° 08′ W. 10.61 to point for Sta. 4,
N. 82° 15′ W. 21.80 to point for Sta. 5,

N. 74° 15′ W. 64.55 to point for Sta. 6, whence we find our true course (6) S. 82° 30′ W., 3.76 to int. post, aforesaid, and 49.51 to Sta. 7 as renewed.

(H.) N. 41° W. 22.50 stake. R. same, set Buckeye post in rock mound.

(E.) N. 40° 53′ W. 22.52 set granite stones b'd'd by stones, etc. This is set at the place of an indifferent mound or gathering of stones covered with wash — but no marks here that are conclusive of the identity of Reynolds' Cor.

(H.) N. 20° W., 12.00 stake. R. same. Set laurel post in stone mound.

(E.) N. 19° 53′ W., 12.05 old stake in mound of stones. "Reynolds' Cor."

(H.) N. 3° W., 53.50 stake. R. at 12.37 int. line bet. T.'s 2 and 3 N., R. 14 W. at 18.42 E. of Cor. to Secs. 1, 2, 35 and 36, set laurel post in mound of rocks and earth, and at 53.50 set sycamore stake on point of bluff in rock mound on left and S. side of Pacoima Cañon — Sta. 10, etc.

(E.) N. 3° W., 12.32 old post oak limb fully marked, in mound of earth with pits, at S. end of a stone wall and standing S. 89° 26′ E., 18.46 chs. from a stake marked for aforesaid Sect. Cor. in a mound of stones and earth with pits.

(E.) Continue course 53.50 to temporary station 10. Our position does not agree with Reynolds' description — we are carried to the left and beyond the point of the bluff as it appears at the present. Before work on the present Pacoima Dam, the spur may have reached further west. We do not know what evidences may be in the knowledge of the owners of the dam and do not attempt to mark this corner, as it is unnecessary for the purpose of this survey.

(H.) N. 50° E., 6.00 to stake. (R.) set sycamore stake in rock mound and marked a tree witness.

(E.) N. 50° E., 6.00 to a temporary cor. After long search can find no witness tree, or other evidences of the cor. Adopt these temporary corners for purpose of required estimate of area.

(H.) N. 16° 30′ E., 105.00 chs. to post marked in rock mound on W. slope about 5.00 chs. E. of mouth of cañon brg. N. 13° W.

(R.) N. 16½° E., 105.00 to old stake in rock mound marked S. F. 12.

(E.) N. 17° 01′ E., 105.34 to a post 4″ x 4″ S. F. 12 in large mound of stones built over an older mound with an old stake marked same. The situation of this corner is such as not to be subject to disturbance by farming or stock, etc. We firmly believe this present well-marked station is the original cor. marked by Hancock.

(H.) N. 66° W., 80 chs. stake on S. W. slope mt. spur. Buildings of Ex. Miss. S. F. brs. S. 34° W.

(R.) N. 66° W., 80 chs. set laurel stake in stone mound on W. slope small spur N. and S. etc. Mission buildings brs. S. 34¼° W.

(E.) N. 66° W., 79.79 to a bar of iron (a railroad fishplate) in old mound of stones — a long-accepted corner by owners of land on both sides of lines running to it. We therefore place our official marks upon granite stone 18 x 15 x 6 ins. set against N. W. side of iron bar in mound of stones.

(H.) S. 86° W., 276.50 stake. (R.) same; set a laurel stake in a small mound of stones on E. slope low spur.

(E.) S. 86° 33′ W. at 56.38 chs. fall 12 links S. of a Redwood stake 3 x 4 ins. driven to surface of ground to mark Ro. bdy. — survey unknown; at 58.68 fall 63 lks. S. of post in mound of earth marked for Sec. 22, T. 3 N. R. 15 W. — find also a round post 50 links S. of the Sec. cor.; *i. e.*, 13 links N. of our random; at 252.68 find old mound of stones on a ridge (to which we sighted from Sta. 13 for this course) — stakes of recent subdivisions of the Ro. in this vicinity conform to this alignment; at 256.47. Enter eucalyptus grove standing mostly to right of line said to have been grown for a tree claim on public lands; at 276.50 leave eucalyptus (at record length of this line). Marked this point for triangulation point — at 283.65 mark 2d triangle point at top and near S. end low spur. A long, diligent search fails to discover corner marked by Reynolds.

(H.) N. 54° 30′ W., 100 chs. road from Los A. to Ft. Tejon—up a Cañada N. 50° W., 132 chs. post S. F. 15 from which an oak 8″ brs. S. 50° 30′ W., 1.59 chs.

(R.) N. 54½° W. at 52 chs. to rugged and steep mt. return, and from 29.00 run traverse as follows:

S. 45¼° W., 31.00
S. 15½° E., 5.44
S. 51° W., 3.64
S. 69½° W. 23.00 in mouth of cañon to S. F. Pass set traverse post IV.

N. 45¼° W., 28.00
N. 70½° W., 10.24
N. 50¾° W., 10.50
N. 24¾° W., 30.50
N. 11½° W., 7.00
N. 46¾° W., 5.77
N. 55¼° W., 7.80
N. 8¾° W., 16.80 to Sta. 15. Set elder post in mound of rocks and earth mkd., etc., making course and dist. N. 54½° W., 132.00 chs.

Live oak 16″ brs. S. 34½° W., 3.53 — sycamore 15″ brs. S. 1° E., 1.11.

(E.) By triangs. across the mts., we find a course and dist. from triangle 1 on last course (276.50 tempo. Sta. 14).

N. 54° 08′ W., 137.43 to iron bolt in mound of stones in a cañon from which a live oak brs. S. 34½° W., 3.52 — scar not opened — from which a sycamore stump brs. S., 1.11; there are no marks remaining. The witness to Sta. 15 taken by Hancock is not found. His course does not directly cross the L. A. & Ft. Tejon road and the dist. 100 chs. falls on the side of a rugged spur. Hancock evidently did not run the course directly, but by traverses. We also note that the recorded traverses of Reynolds do not connect same points given as resulting course. We accept the stone mound as the well-known corner sought.

(H.) S. 47° 45′ W., 182 to black walnut 5″ marked S. F. 16, on N. W. slope of high hill.

(R.) Run traverses making course and dis. S. 47° 40′ W., 184.47 (but adopts Hancock's entry), to black walnut tree 8″, marked S. F. 16, on N. slope near summit of high mt. of Sta. Susunna Range.

(E.) By triangs. over deep cañons and precipitous slopes of mt. spurs, run S. 47° 44′ W. (corrected course), 187.02 chs., to a walnut situated as described in patent "on N. W. slope of high hill." We find no marks. An older stem has probably disappeared. We take pains to perpetuate this point as the true cor. of the Ro.

(H.) N. 75° 30′ W., 194.00 to oak 20″ dia. mkd. S. F. 17.

(R.) By traverses to Sta. 18 and thence retracing to 17, makes this No. 80¾° W., *154.63* to post oak *22″* marked S. F. 17.

(E.) N. 74° 35′ W., 149.29 to a post oak marked by Deputy Hancock, now 37″ dia., etc.

Note.—At the time of making the survey, myself and associates felt very certain this was the Hancock tree corner, though a little surprised, so that we reported, "That Mr. Reynolds should have varied so much in attempting to correct the original minutes seems inexplicable."

None of the "squatters" had interest or dispute about the E. and N. boundaries of the rancho. The defendant lawyers, however, began their attacks upon the evidence of our survey from this point, not as to a question of precise adverse possession — but rather contending that Hancock's survey was thus uncertain, and hence invalid. It is very evident as to Hancock's errors in course and distance. The writer is not now so certain as to Reynolds' misstatement. Some years since our survey and after the contest in court, it came to the writer's knowledge that a certain surveyor was searching for the Cor. 17 without being able to find a tree so numbered, but he did find this tree *scarped* as now; he concluded the numbering had inadvertently been omitted, and placed the marks now seen thereon. Here is an instance hinting at the importance of a public record of all landmarks and their alterations and obliterations in retracements, by whomsoever made.

(H.) S. 75° W., 26.50 to post mkd. S. F. 18 in rock mound — a station of the Coast Survey.

(R.) Same in large coral lime rock mound . . . on summit of a high smooth mt. of the Sta. Susanna Range. This station has been one for the U. S. Coast Survey.

(E.) S. 57° 36′ W., 28.90 to Sta. 18 a polished sandstone 5 x 5 ins. square, imbedded in the ground even with the surface, marked U. S. C. S. on top end, etc., situated as described by the Coast Survey Department. The large mound of limestone rocks thereon has been replaced around a pine post standing end upon the said U. S. C. S. stone, etc.

Note.— There is no question as to this U. S. C. S. station as a point in the boundary of the patent by Hancock's survey. It appeared in Reynold's notes that he first connected Stas. 16 and 18 by traverses and from 18 located Sta. 17 directly, as the surface of the mountain top permits. We did not find any cor. marks by running back thus, but being confronted by a tree so marked, as already written, we yielded to its influence; its evidence being fraudulent, in the absence of the tree accepted by H. and R. Cor. 17 should be located by a reverse course from Sta. 18 and the preceding course amended accordingly.

(H.) S. 38° W., 15.00 stake. R. Same; descending mt.; set black walnut post in mound of sand stones.

(E.) S. 38° W., descending slope of mt. along fence for Ro. inclosure to head of spur, 14.95, find no cor. (marked tree witness).

(H.) S. 4° 45′ W., 62.50 stake. R. same. Set a black walnut stake in rock mound.

(E.) S. 4° 47′ W. (Va. 15.00° E.), 62.64 to stake in large mound of stones — at cor. of wire fences.

(H.) S. 77° 30′ W., at 14.00 spring S. 35° E., 2.00; at *51.00* cross stream 8 links at 60.00 stake. R. same course, at *47.00* cross stream, etc., 60, set black walnut stake in rock mound.

(E.) S. 77° 37′ W., along fence inclosing Ro. at 12.50 spring S. 11¾° W., 2.00. This agrees with Hancock. A spring with several issues is not a point of precision. At 52.01 2 links N. of stone mound said to have been raised by Jackson or Healy, surveyors. At 61.01, being 9.00 chains cross stream noted by Hancock at 51.00, R. at 47.00. It is confined in a gorge 10 ft. deep, 30 lks. wide. At 60.76 fall over the creek, tempo. Sta. 21. The inclosure extends on to 65.64 warranted probably by some closing cors. of public surveys not yet approved. In this case the original distance given, 9.00 chs. from stream crossing to Station 21, seems more precise than dist. 60.00 from Sta. 20, somewhat uncertain itself.

From their station 21 the surveys of both the Patent and Partition read the same by course and whole dists. to Sta. 30, which Reynolds marked with a stake on N. slope of a hill in chapparel, but the topography seems to greatly vary as far as given.

(H. & R.) S. 13½° W., 88.00 stake — to Sta. 22
" S. 7° E., 27.00 stake — to Sta. 23
" S. 83° W., 1.00 stake — to Sta. 24
" S. 7° E., 10.50 stake — to Sta. 25
" S. 24° E., 2.50 stake — to Sta. 26
" S. 15° W., 5.00 stake — to Sta. 27
" S. 5° W., 1.00 stake — to Sta. 28
" S. 22½° W., 7.00 stake — to Sta. 29
" S. 41° W., 6.00 stake — to Sta. 30, (R.) on N. slope of hill.

(E.) After various trial lines to reconcile the points of topography given, connected the point noted as tempo. Sta. 21 with the "old stake in well-preserved mound of stones marked S. F. 30" (which we feel sure is the corner made or adopted by Reynolds), in the following courses (by deductions from offset and random lines run):

(E.) S. 13° 38′ W. at 84.00 cross Mormon Creek. (Hancock noted that at 84.00 he "crossed stream 8 lks. wide.") At 88.05 to point for Sta. 22, at bottom and just E. of mt. spur. In the absence of decisive marks for the corner we use this point for estimate of area, and as agreeing with dist. from stream crossed.

(E.) S. 7° 05′ E., at 4.50 cross creek Southwesterly. (Hancock gives 4.50 cross stream S. 35° W., and again at *17.00* chs. cross stream S. 42° E.) We find at *7.00* chs. recross stream Southeasterly at 27.00 dist. called for; no marks for Sta. 23. Carry line forward to 28.12 to be tempo. Sta.— a point opposite marks for Sta. 24.

(E.) S. 82° 55′ W. (crossing Mormon Creek), 6.20 to a sandstone rock chisel-marked S. F. 24, at the top of a narrow, high spur of mt. on the W. side of the cañon just left. From which a stone also marked S. F. 23 on same ridge bears S. 65° E., dist. .96. We totally reject this as original 23, as not in proper course and dist. The stones are not marks by Reynolds (or H.). R. mentions the situation of this cor., "Set *marked stake* S. F. 24, 20 links from top of steep ridge on S. slope."

(E.) S. 6° 50′ E. (from the stone S. F. 24), 9.66 to sandstone in mound of stones — no marks. H. and R. describe stakes only.

(E.) S. 23° 49′ E., 241 to sandstone in mound of stones on brushy slope.

(E.) S. 15° 11′ W., 4.97 across gulch bearing easterly to sandstone in mound.

(E.) S. 5° 11′ W., 1.00 to sandstone 24 x 12 x 6 ins. marked 28, in mound of stones. H. and R. only set stakes.

(E.) S. 22° 41′ W., cross brushy, rocky ridge 7.00 to stone 20″ long marked 29, in mound of stones at foot of sharp descent; an old stake here burnt to the ground. H. and R. set stakes for 29.

(E.) S. 41° 11′ W., at 3.00 cross water in cañon about 3.00 chs. to right of the Reservoir at 5.97 to old stake in good mound of stones marked S. F. 30. This, by its relation to the following course, we are confident is Reynolds' Sta. 30. It is in the brush and has been hidden from general observation.

Notes.— While we endeavored to exhaust all the field evidence, it was not then incumbent upon us nor has it been since to decide upon the restoration of the exact corners of the Ro. between S. F. 18 and S. F. 30. No trespassers were found along this border to dispute the exact extent of the Ro. here. The owners of the N. ½ were indifferent as to the survey which was the burden of the owners of the S. ½, plaintiffs. While topography is seldom very precise, we think the crossing of streams found to be as definite as the ones given by Hancock in courses 20 and 21 would limit lengths, where the cor. marks were obliterated. We incline to hold to course 22 as noted between the temporary stations, as conforming to Hancock's notation of stream crossings, nevertheless what is recorded as 17 chs. is found to be 7 chs. If we close this line at given dist. 27.00, we have some excess of dist. to distribute thence to Sta. 30, while we have the next course greatly in excess of the call of the patent. Between an erratic compassman and the reader in the office has the dist. in course 23 been reduced from *7.00* to *1.00?* We opine we must hold to the record, seeing the landmarks do not give us definite points by which to amend it. We have no history of the origin of the stone cors. 23 to 29. Would it be judicial to presume largely that the stone mounds are the seats of R.'s several sta. stakes. What did Reynolds find of Hancock's stations to guide him through the discrepancies. Of these last courses he says of Courses 28 and 30, "retracing official survey." It is rather evident that he retraced the Patent courses from Sta. 30 backward. He would have about 4.50 chs. excess. Does he

thus, by deduction, vary over 4.00 chs. from Hancock's crossing of stream in course 20? Projecting this course 65.64 to point in line of fence built to inclose Ro. on course 21, we ran as follows:

(E.) (trial line). S. 13° 38′ W., along lines of fence, at 30 creek 3.70° W., at 37.18 stone in mound of stones; at 58.60 post marked T.'s 2 and 3 N. R. 16 W., U. S. Dep. Lovejoy's survey not accepted; at 64.98 p. marked closing cor. bet. 2 and 3 by Dep. Hall, survey not accepted; at 65.95 Mormon Crk. brgs. soon move W.; at 69.72 old mound of stones; at 77.43 to a point 10 ins. E. of pointed stake in mound at foot of bluff S. S. E., said to be Healy's survey; 81.00 mound of stones at top of spur; at 85.50 to old stake and mound of stones in cañon brg. S. S. E. and just beyond roadway in valley corner said to have been Jackson's survey. If we begin at aforesaid stone marked S. F. 24 and thence reverse (H. & R.) courses, we bring Sta. 22 to very near this corner, which was intended by Jackson, no doubt. It must be observed that Hancock kept down Mormon Cañon by traverses and perhaps well out into the plain by traverses from which he located his stations from 22 to 31 (the dead oak). Lastly, the writer will suggest that if course 22 be changed from S. 7° E. to S. 7° W. it would facilitate the adjustment of errors of dist. But these surmises are not evidence and of no value except as suggestions as to further attempts to discover available facts. The evidence so far seems to warrant the setting of Sta. 23 at 27 chs. in course 22 given by E. as the sta. of patent, and joining the station to that of Sta. 24 as found marked most probably as the corner fixed by Reynolds and approved by the county court. However, if R. in course 20 ran 13.00 chs. after crossing the stream, the court survey takes in the whole of Mormon Cañon, as do Jackson's and Healy's surveys. It is up to the U. S. surveyors to fix these boundaries. Our notes with explanations have been filed with the Department.

(H.) S. 38° W., 272.00 to dead oak, 18″ diam. mkd. S. F. 31, at base Sta. Susanna Mts.

(R.) S. 38° W.—"retracing line of official survey"—34.92. Base of low sand rock hills 112.79 to white oak 38″, house of Ramon Hererina brs. N. W. 1.00; 174.42 cross Overland Stage Road N. 43° W., 272.00 dead white oak stump, mkd. S. F. 31.

(E.) After random line S. 38° 03′ W., 33.20, leave rocky hill and enter level plain, beginning of line of fence for inclosure of Ro. is .85 links W.; 113.00 chs. fall .65 E. of white oak 36″ dia. given by R. as a line tree, from which an old adobe building bears N. 35° W., 1.08 (this tree is S. 38° 21′ W., 113.00); 173.06 cross old stage road; 273.64 redwood post 4 feet high, said to have been set according to surveys by both Jackson and Healy. The old stump was seen by Jackson in 1885 with marks discernible. We are unable to find any evidences of it, except Jackson's witness marks. Jackson, agreeably to Reynolds' notes, evidently had run from this post in the alignment of the tree, and at 271.44 set a stake for Sta. 30, which bears S. 60° 32′ W., 2.48 from the R. cor. which J. did not discover on the brushy hill top. We accept the post at Sta. 31 as true corner, reject J.'s Sta. 30, and think Reynolds erred in making the oak as stated a "line tree," though the court's approval of his survey and adverse possession now makes it a bound. The fence on Jackson's line N. of the tree, however, is not on true line.

(H.) S. 39° W., 8.30 stake. R. same, "to point on northern slope of low, rolling hills, stake marked S. F. 32 station."

(E.) S. 39° 18′ W., 8.32 to redwood post 4′ high in mound with an old stake marked for Sta. 32. Accepted as true corner.

(H.) N. 85° 30′ W., 72.00 large sandstone rock 9′x 2′x 3′ imbedded in earth marked S. F. 33 at easterly base of Santa Susanna Mts., from which a live oak 10″ brs. S. 74° 30′ E., 4.50 chs.

(R.) N. 85½° W., retracing line of official survey, 59.00 cross arroyo in center of ravine, comes from N. 7° W., runs S. 27° E., 72.00 raised mound of rock on top large sandstone outcropping on east face of rocky mts. of Santa Susanna mkd. S. F. & S. 11. Set black oak stake mkd. S. F. 33. . . .

(E.) After a random. S. 85° 12′ W. 51.55 and 64 00 low hills ranging N. & S.; 71.38 to Sta. 33 described, a large sandstone rock "in place," cropping out of surface at easterly base of the Santa Susanna Mts., about 12′ long N. E. & S. W., with a step or face to S. E., on which were cut the letters and figures S. F. S. 33 for Sta. 33 and also older marks, S. F. and S. 11.

Notes.— In the trial courts this station was vigorously assailed as not relatively situated according to Patent dist. in course 16, *viz.,* nearly 40.00 chs. farther W. than R. found it, and the U. S. C. S. allows it to be; nor as reference in the next course (33) would locate it. Notwithstanding some uncertainty as to the precise situation of the stations of the Patent Survey from the certain one of 18 (U. S. C. S. mon.) to Sta. 30, we considered this absolutely a certain cor. of the Hancock Survey; such notes of topography as are given along these lines, and especially of the situation of Stas. 31 and 33, "at base of Sta. S. Mts.," could not be answered by the location of the same courses at the half mile farther W., on the tops of the mts. The older marks S. F. signify, we believe, San Fernando (Rancho), and S. 11 for sum Ro. Sta. 11 in a rejected survey for that Ro. The final survey of the simi did not make it adjoin the S. F. Ro., as had been supposed it would.

(H.) S. 12° 30′ W., 182.00 to stake. Intersect S. bdy. Tp. 21 N. R. 17 W., 215.00 W. of cor. 3, 4, 33 and 34; at 203.00 live oak 24″ mkd. S. F. 34, from which an oak 18″ brs. S. 7° W., 1.68.

(R.) S. 12½° W., at 182.30 Int. So. bdy. T. 2 N., R. 17 W., 15.92 E. of cor. to Secs. 3, 4, 33, 34; at 205.10 to a forked white oak tree 25″ dia. being Sta. 34 S. F., and Sta. 4 and N. W. cor. official survey Ro. El Escorpion. . . . Another white oak 20″ dia. bears S. 7° W., 168 lks.

(E.) After randoms run, find S. 11° 42′ W., at 99.27 point, fixed by Reynolds as H. A. 6 (the N. W. cor. of the Homestead Assoc. in the partition), no marks found here; at 181.46 int. N. line of T. at 15.54, N. 87° 55′ E. of the stake in mound of stones, mkd. for cor. secs. 3, 4, 33 and 34. (The ¼ sec. cor. bet. 3 and 34 is found); at 203.19 the old oak tree described in patent, except it appears to be "white oak," instead of "live oak," and the tree is now fallen. This tree is marked S. F. 34, and E. E. 4; also upon the inside of the bark grown over the old scarping, when now removed, find reverse of the marks S. F. and S. 10 (of the series S. F. and S. 11 at preceding sta.), while the original marks on the body of the tree had been destroyed by worms. We find the evidences of the brg. tree of Hancock; also the added ones of Reynolds.

Notes.— The cor. here was assailed, as stated ante. Hancock's int. of the Tp. bdy. is stated to be 25.00 *W.* of *sec. cor.,* instead of about 15.00 chs. E., an error of about 40.00 chs. The point may have been connected to the ¼ *sec. cor.,* being nearer H.'s traverses probably run to avoid rough, brushy ground, and by "judging" referred to the sect. cor (to suit plotting using H.'s distance in course 16). The "scab" from the cor. tree showing reversed marks, was exhibited in court. Set marked stone, etc., and later put in a masonry corner.

(H.) S. 84° E., on N. bdy. Ro. El Escorpion 105.34 post S. F. and chrd. stake in mound. R. also notes marks E. E. 3 (added since Hancock's Survey, for Survey Ro. El Escorpion — forming a square notch in the W. side of Ro. S. F.).

(E.) S. 83° 56′ E., 105.80; a mound of rocks, under which deeply in ground was found chrd. bottom of oak stake stated in Patent (Sta. 35). (Set large stone, etc., and later put up a masonry cor., as the stone had been removed.)

(H.) S. 6° W., 105.34, post S. F. 36, etc. R. same — added witnesses, etc. This had also been marked E. E. 2.

(E.) S. 5° 53′ W., 105.79 — re-established cor. by evidence of witnesses remaining. Set limestone 35″ x 8″ x 3″ half in ground, etc.; later put up masonry cor.

(H.) N. 84° W. (along bdy. El Escorpion), 105.34, post marked in stone mound. A cor. Las Virgenes Ro. at E. base of Santa Susanna Mts. S. F. 37.

(R.) Same crs. and dist. set black oak stake in mound of rocks; being Sta. 1 of Ro. El E., also set at E. base of ridge Sierra Sta. Susanna.

(E.) N. 83° 41′ W. bet. Ros. S. F. and E. E., 105.54 to Redwood post 4″ x 4″ 5 1-3 ft. long; set through a mound of stones at top of first slope. Ensign first visited this cor. December, 1888, where he found a good mound of stones long undisturbed. The old post had lately been destroyed; its socket or hole through the mound and into the ground was then distinct. From this corner (Sta. S. F. 37), a post since set by Deputy Hall (survey not approved) for same cor. stands S. 24° 35′ E., 1.00 dist.

(H.) S. 33° 30′ E. along bdy. of Los Virgenes Ro., 158.00 to live oak 40″, mkd. with cross, D. and S. F. 38, and an old bdy. mark, on N. side of road to Santa Barbara and in W. side dry gulch .20 wide, crs. N. W.

(R.) S. 32° 37′ E., leaving Ro. E. E. over rolling grassy hills, . . . 161.51 to a live oak 45″, mkd. W. side D+. This oak is on N. side of old road from L. A. to Sta. B., crs. W.; the road now runs on E. side of tree up bank 60 lks. from tree, and then turns W. and meets old road about 11.00 W. of tree. (Marked several witness trees here.) The official course was S. 33° 30′ E., 158 chs., making a difference of 53′ in course and 3.51 in dist., which over good ground is beyond the limit of admisible error, and I adopt as the true course that which I have given above.

(E.) S. 32° 48′ E., through redwood posts 5′ l., 4″ x 4″, set in 1888 in line at the summits of hills (ridges) at 19.93, 40.89, 51.88, 70.90, 88.80, 123.77, 141.94. Also set such post in bottom of valley at 113.77. Also note at 41.28 intersect Glover & Reilly's line bet. secs. 10 and 15 T. 1 N. R. 17 W., at .30 W. of mkd. post. At 136.56 int. their line bet. secs. 15 and 22 at .85 lks. W. of mkd. corner; at 138.67 1.97 W. of int. p. N. line sec. 22, Hall's survey; at 143.40, 1.97 W. of int. p. E. line sec. 22, Hall's survey (work of U. S. dep. surveyors G. & R. and Hall not approved); at 161.32 the cor. Sta. 38; at point closely attested by witnesses noted by R. In 1888, E. found remains of root prongs in the ground of old station tree, in S. W. bank of the arroyo (dry gulch) named with marks of the old stage road crossing thereat, not yet wholly obliterated, agreeing with R.'s wit. trees.

Notes.— As stated at Sta. 33, 34 and 37 defendants would show by inference and some unimportant evidence that H.'s patent survey lay ½ m. W. at Sta. 38, they brought forward witnesses to show that the old stage crossing referred to was at another tree at the arroyo, 26.00 chs. N. E. from the true cor. One of Mr. R.'s helpers was found, however, who testified that the cor. tree with its marks was standing when R. came to it and marked the witness trees. Defendants show no witness trees at their point.

(H.) S. 53° 30′ E., 92.00, blazed live oak 18″, at East side of Canada de las Calabasas from S. W.

(R.) S. 36¼° E., at 44.96 int. offset base line at 133.35 W. of cor. 58.00 S. of cor. secs. 13, 18, 19 and 24 R. line bet. R.'s 16 and 17, T. 1 N.; at 76.70 to blazed *white* oak tree

23″ dia., marked as Sta. 39. (Mkd. two wit. trees to this.) The off. surv. called for here was S. 53½° E., 92.00 chs. dist. The two stations being natural objects, I connect them as above set forth.

(E.) (1888.) S. 36° 40′ E., at 7.45 cor. of old inclosure of public land claimed by M. Leonis just east of store of Antunez & Son; thence along a post and board fence built for claim of Leonis as bdy. Las Virgenes Ro. 76.55 a white oak at top of bluff E. bank of Canada, the tree found by R. as the one marked (as a live oak) by Hancock at Sta. 39.

We find the witness trees as given by R.; the H. marks have been obliterated by worms.

This is a co-boundary of the Ro. Las Vírgenes; and this tree was marked by Dep. Minto, whose survey has been approved by the Department. (*Note.*— The claim of M. Leonis for a portion of the former grant was still pending at time of our surveys, but subsequently was disallowed by default of the Mexican grantee delayed bringing claim.)

(H.) N. 58° 30′ E., 25 live oak 30″, mkd. S. F. 40.

(R.) N. 58½° E., 25 live oak 35″, S. F. 40. (R. marked here two wit. trees.)

(E.) (1888.) N 49° 44′ E., 24.76 to a live oak 40″ dia., mkd. S. F., S. 40 and H. A. These marks we believe to have been put on by R., the older marks are partly discernible, but evidently were blazed off for remarking. This tree more nearly answers by course and dist. the calls of course 38, has been taken by several surveyors as that meant for Sta. 39, notwithstanding the number thereon (40). Surveyors of the public land have so taken it; and adopted a large live oak at N. 55° 12′ E., 16.60, on which are no proper marks, as Sta. 40, etc. Reynolds' wit. trees are in evidence (1888, but one has disappeared, 1892). Leaving out Reynolds' evidence and this tree (Sta. 40) still does not answer the call for one standing at the E. side of the Cañada, etc., as this is the middle of a bay of the even plains. Mr. Hancock adds to his notes, under "Remarks," etc.: "The Ro. Las Virgenes borders on this tract from the Ro. El Escorpion of the Indians to the S. W. cor." The fence (crs. 38) and Minto's survey (1879) show the accepted boundary of the Las V. by claimants and the government.

Notes.— Here again defendants labored hard to discredit course 38. Besides wishing to prove the invalidity of the grant by the uncertainty of the patent bdys., they desired to save the premises of the homesteaders who had quite innocently supposed his location outside the Ro., as the U. S. surveyors had marked it (surveys not approved). In this quarter there was some disposition to be violent toward plaintiff's agents: in the survey in 1892 a committee of the settlers notified us not to cross their locations for the replacement of course 38. E. had carefully run this line in 1888; it was easy to use triangulations for our purposes of connecting the stations at this time, and to avoid any collision or hard words. Hancock's text of notes filed in S. Gen. O. is, "To Sta. 39 and blazed a live oak 18 ins. dia. situated on the East side of the mouth of a broad cañada called the Cañada de las Calabasas or Squashes, coming from the S. W." These added words deny the contention that the tree marked "S. F. 40" at the foot of a line of hills forming the head of a bay of the level plain stretching from thence to main valley to the N., and about midway along this foothill border. S. F. 40 is not at the mouth of the cañada which is formed between hills and coming from the S. W. to this mouth, but the tree witnessed as 39 by R. fills such description.

(H.) N. 89° E., 39.00 brown sandstone rock 20″ l. 8″ x 4″, mkd. S. F. 41, on N. W. slope mt. spur. R. same crs and dist. to brown sandstone 24 x 9 x 4, marked S. F. 41.

(E.) (1888.) N. 88° 34′ E., 38.77, found a mound of sandstones, "on the N. W. slope of mountain spur." This mound has apparently been undisturbed for long time, and contained stone mkd. H. A., but the large stone noted not here. *Notes.* — If we run this course from the (unmarked) tree used by U. S. deputy surveyors for S. 40, we find no early marks nor a point on said "N. W. slope," etc., for S. F. 41.

(H.) S. 65° E., 272 sandstone 12″ x 12″ x 10″, S. F. 42 at a high point on the mt.

(R.) S. 65¾° E , over rough mt range, 272.00 to a sandstone rock 12 x 12 x 10 ins., mkd. S. F. 42, etc., at a high point on the mt. "Broken Mts."

(E.) S. 65° 24′ E., at 6.75, 21.10. 38.80, 62.65, 78.26, 146.00, 169.60, 193.00, 221.50, through redwood posts 5′ long, 4″ x 4″ sq., on various brushy ridges, slight change of var. of needle last 3 points; at 257.23 to large sandstone set in mound of stones mkd. S. F. 42 on high conical peak,

as described in original surveys; a post mkd. S. V. S. M. 8 Sta. Ro. San Vicente y Santa Monica) is found lying alongside. This is the highest point of the range and well known as a common corner of the several Ros.

Notes.— Both H. and R. derived their distances by traverses into the plain and then following up a long spur of this mt. E. measured by triangs.— bases measured on the level plain repeated by W. and N.

Notwithstanding the certainty of this peak and its marks, considerable attempt was made to show that a rounded swell on one of its spurs, by its relation to the erratic public land surveys, must be the high point called for by Patent.

(H.) N. 84° E., 345.00. An irregular mound of rocks on high peak about 500′ above S. F. valley, from which ¼ *cor.* S. 19 and 24 T. 1 N. R.'s 15 and 16 W. brs. N. 28° W., 111.00 chs.

(R.) N. 87½° E., over rugged mt., 327.97, to an irregular mound of rocks on a very high peak about 800′ above S. F. valley. Found large sandstone rock 24 x 16 x 8 ins., marked S. F.; marked same S. F. 43, and made irregular rock mound Broken Mts. The cor. at *secs. 19, 24, 25 and 30* bet. R.'s 15 and 16 W., brs. N. 23¾° W., 107.11 chs. dist., . . . by two traverses run by me, I find the same to be as above set forth.

(E.) N. 88° 33′ E., at 23.10, 54.50, 104.35, 137.35, 147.80, 257.80 and 288.60, through marked posts 5′ x 4″ x 4″, etc., to mark line; 329.00 to post in mound of earth and stones at top of high peak, Sta. 43 of Patent and Partition Surveys, from which the cor. to secs. 19, 24, 25 and 30 T.'s 1 N. R.'s 15 and 16 W. brs. N. 23° 30′ W., 99.73 chs.; also a small mound of stones containing a stone marked S. F. 43, recently (1891) put up by H. J. Stevenson, surveyor, as a restoration of the cor. (missing?), brs. N. 7° 09′ W., 38.80 chs. Mr. S. says this stone was found at the foot of the spur adown the steep slope of which it had rolled. He put it in place again opposite to point of finding it and in accordance with its original relation to the ¼ sec. cor. to which Hancock tied Sta. 43, according to S. estimate of same.

We spent several days in examining all this ground and the corners involved. The "high peak" to which we

run this course, is the only one in the vicinity, except one still farther S. W. Ensign first sought to identify this cor. soon after trespasses commenced on the S. F. Ro. (1891). He was led to this conspicuous summit by reference to R.'s connection, but there was no monument to be seen,—"irregular stone mound,"—as expected. On the exact summit appeared some old brush, as if negligently thrown aside, but an open pile in which the mound should be seen. It was concluded to dig for stones, and the brush was removed, no stones found, but here a refilled pit of soft (dry) earth. (It was in California dry season — no sward forms here.) Then it was seen that the steep slope of the peak on the W. began almost at the edge of the old mound — and here were the marks on the earth slopes where the constituency of the said mound of stones had "rolled away," and down into the gulch below. A number of them were found — the marks of their movements had not been washed by rains. It appeared probable, too, that from the point of reaching the preceding Sta. Com. Cor. to Ro. S. V. S. M., which lay principally on the other slope of the mt. range, and more particularly in tracing the bdy. more eastward — "the mts. of Portesuelo," Hancock intended to follow as nearly as practicable the summit of the range. Also corroborating this pit and peak, we find a line of posts set by J. E. Jackson, C. E., running back from Sta. 44, to this point exactly. (Jackson subsequently testified to having found the old mon. in good shape on this peak.) We further deny that the Stevenson mound is the corner, though believing the marked stone might have traveled from the true cor. If the marked stone in the "irregular mound" of the patent had rolled out of its nest, the nest would have been found on the mt. below — vegetation had not disappeared under this reconstructed mound — a new cor. surely. Though located on a spur coming down from the peak, there was no sort of a peak here or in this vicinity. If there were an attempt to locate the Sta. 43 by connection to the ¼ sec. cor. misnamed by Hancock, the call for a "peak" didn't well fit any ground reached. Reynolds, no doubt, ran to the peak we re-monument, and we are confident he found the Hancock Sta. (of the Patent). The Patent Survey (Minto's) for S. V. y S. M. calls for Stas. 42 and 43 and

part of course 44 is co-boundary. No marks found, except at Sta. 42, as stated.

Notes.— As we had fully examined the ground and discovered the Comet corner, and testified to the facts found, defendants did not attempt any great surprises with their averments and explanations through their surveys. It will be seen that "shortage" found by us in the last two courses largely offsets the error made by Hancock in his course 16. Probably some "fudging" here in patent survey.

(H.) S. 83° 15′ E., 668.00 sand rock buried in earth, face 14″ dia., mkd. S. F. 44, on W. side road Los Angeles to San Fernando, brg. N. W. in Cahuenga Pass, etc.

(R.) S. 87° E., 680.50 to a sandstone rock mkd. S. F. 44, etc. The official course calls for S. 83¼° E., 668.00. After running three traverses I find the crs. and dist. as near as may be to correspond with that herein set forth. . .

(E.) S. 86° 57′ E., at 122.40, 207.41, 246.00, 361.50, 381.60, 402.60, 413.85, set redwood posts 4′ x 4″ x 4″ to mark line, 570.44 large mound of stones around stake. R.'s Sta. "X10" about 50 lks. N. of summit of high rocky peak; at 683.36 to S. F. Sta. 44 summit Cahuengo Pass. Found line of stakes Jackson's former alignment of this course.

(H.) N. 12° 37′ E., 57.79 to point of beginning (121,396.13 acres).

(R.) N. 7° 15′ E. at 1.50 cross Overland Stage Road N. 35° W., etc., at 61.34 . . . and place of beginning. . . . Nearly all of the while I was executing the foregoing survey the Commissioners were present and verified the above work, etc., etc.

(E.) N. 7° 05′ E., at 1.00 cross old road not now used; 2.40 to fences and along same, at 61.10 to Sta. 1, place of beginning. Containing 121,311.10 acres; less the Ro. El Encino and the Mission of S. F. Tracts, wholly within the Ro. S. F., as per Patents (4,537.67 acres). Acres of this grant = 116,773.43.

The Commissioners in Court partition awarded division along the sect. lines one mile N. of the bdy. bet. Ts. 1 and 2 N. Reynolds' estimate 59,550.8 acres, excluding Ro. El Encino — to the "Homestead Association." The trial court charged "that

the Patent which was the final act of a series of acts in settlement of Celis claim, concludes everything, and is our guide. It was all provided for by Congress;" that adverse possession founded on a decree of a competent court taken in good faith upon the survey accepted by the court, and so held five years, if plaintiffs have paid taxes, is good against everybody but the government. The complaint conforms to the Reynolds' survey. It matters not whether the patent includes more than the Mexican grant or not. The jury are to decide where the boundaries run. It is not necessary to show that every course and distance in the patent accords with those found on the ground; the record must yield to the monuments. Intention to make common boundary between ranchos, as in the case of the El Escorpion, and the San Vicente y Santa Monica, must prevail.

Jury rendered verdict according to the Reynolds survey, court ordered that plaintiffs do have and recover from defendants' premises (describing same) and that title be quieted. (Case 16,240, Superior Court, Los Angeles Co., Cal.)

Another case was brought (No. 16,393, same court) to eject parties who attempted more especially to homestead the parcels outside of the U. S. surveys (never approved) running inside the patent boundaries from station 37 to station 42. The "Squatters' Association" evidently desired to bring the matter into court again to attack the validity of the patent, because of the nonexistence of a good grant from the Mexican government, and for uncertainty of surveys under precedents thought to have been discovered, and they employed eminent counsel. Plaintiffs were given judgment confirming stations 39, 40, 41 and 42, according to Reynolds' and E.'s surveys. The case was taken on appeal to the State Supreme Court, and then to the United States Supreme Court, where judgment below was repeatedly confirmed. A part of Syllabi 117 Cal. 594. . . . The patent of United States to land claimed under Mexican grant is the government declaration that it was valid under the laws of Mexico.

. . . Nor can the mere fact of discrepancy between different surveys of the tract described in the patent as to courses and distances merely, prove that the description is so indefinite as to render it void, but the description is sufficiently definite if the entire body of field notes described are sufficient data for its location. 180 U. S. Reports (Bancroft), p. 72. The court rea-

soned if there should be wrong decision (by the Commissioners), the remedy was not by collateral attack, etc. The statute provided the remedy. It allowed appeal to the United States District Court and then to this Court. . . . The scheme of adjudication was made complete and all the purpose of an act to give repose to title was accomplished, and it was certainly the purpose of the Act of 1857 to give repose to titles.

Syllabus.— The papers offered in evidence in this case (deed of Governor Pico and acts of Claim Land Commissioners), instead of showing nonexistence of special circumstances with reference to the sale to de Celis which authorized the Governor to condition of the plaintiff in error is reduced to this dilemma: make it, affirm the existence of those circumstances; and the the papers being ruled out, the validity of the grant will be implied; the papers being ruled in, the validity of the grant will be shown.

APPORTIONMENT OF COST OF SURVEYS.

D. A. BROTHERTON.

If selfishness, avarice and kindred diseases of human nature were to leave the people of this world, then, and only then, would we encounter no trouble in dividing the expenses of surveys among those interested in the work.

Should such ailments cease, the surveyor's business would reach a minimum, if not entirely disappear, and we would have no troubles over lines and corners.

Human nature being such as it is, the world is filled with trouble, and the surveyor makes his living by settling disputes and doing work calculated to prevent future quarrels.

Nor does the surveyor's work always end when the lines and corners are established.

Ordinarily, the expenses of a survey are paid by one party or divided equally or by a simple proportion among several parties; but we will occasionally meet with cases that require close figuring to satisfy the different ones interested.

One man may have his land all cleared, while the lines necessary for an accurate subdivision of the section may run for a considerable distance through timber, possibly thick brush or swamp. Such a man sometimes objects to paying an equal share for the extra time involved in running lines through thick portions of the section, though such lines are indispensable to the establishment of his own corners and lines.

When I was first called upon to divide the expenses of a survey under such conditions, the apportionment I made was satisfactory to all concerned. Not having seen any better plan, I have since then used the table prepared at that time, with modifications where the circumstances required them.

An accurate account was kept of the time spent on each quarter line and on each half mile of the other lines. Dividing the cost of each of these lines into two equal parts, one part was apportioned equally among all of the forties affected by the given line, and the other part equally among or between those forties adjacent to such line.

Table for Apportioning cost of Surveys

	N.E.¼ of N.E.¼	N.W.¼ of N.E.¼	S.W.¼ of N.E.¼	S.E.¼ of N.E.¼	N.E.¼ of N.W.¼	N.W.¼ of N.W.¼	S.W.¼ of N.W.¼	S.E.¼ of N.W.¼	N.E.¼ of S.W.¼	N.W.¼ of S.W.¼	S.W.¼ of S.W.¼	S.E.¼ of S.W.¼	N.E.¼ of S.E.¼	N.W.¼ of S.E.¼	S.W.¼ of S.E.¼	S.E.¼ of S.E.¼	TOTALS
E. ½ of N. Line	6	6	2	2													16
W. ½ of N. "					6	6	2	2									16
N. ½ of W "					2	6	6	2									16
S. ½ of W. "									2	6	6	2					16
E. ½ of S. "													2	2	6	6	16
W. ½ of S. "									2	2	6	6					16
N. ½ of E. "	6	2	2	6													16
S. ½ of E. "													6	2	2	6	16
N. and S. ¼ "	1	3	3	1	3	1	1	3	3	1	1	3	1	3	3	1	32
E. and W. ¼ "	1	1	3	3	1	1	3	3	3	3	1	1	3	3	1	1	32
E. ½ of N. ⅛ "	4	4	4	4													16
W. ½ of N. ⅛ "					4	4	4	4	4								16
N. ½ of W. ⅛ "					4	4	4	4	4								16
S. ½ of W. ⅛ "									4	4	4	4	4				16
E. ½ of S. ⅛ "													4	4	4	4	16
W. ½ of S. ⅛ "									4	4	4	4					16
N. ½ of E. ⅛ "	4	4	4	4													16
S. ½ of E. ⅛ "													4	4	4	4	16
Totals	22	20	18	20	20	22	20	18	18	20	22	20	20	18	20	22	

Keep account of cost of each line and part of line as given in first column. On a diagram similar to the above, place such cost in its proper place in last column (marked "totals") and by proportion get the part belonging to each forty, and place such amount in its proper column

Representing the cost of the N. and S. quarter line at thirty-two (32), one half, or sixteen (16), would be divided equally among all of the forties in the section, as the interior of N. and S. lines of every forty are dependent on the position of the N. and S. quarter line. The other sixteen (16) would be divided equally among the eight (8) forties adjacent to the line, making the apportionment to each of such adjacent forties three (3) and to each of the others one (1) for that particular line.

The apportionment for the E. and W. quarter line would be made similarly, and we would find the cost of surveying the quarter lines apportioned as follows: each corner forty allotted two (2), each forty contiguous to the center corner six (6) and each of the others four (4).

The cost of each half of the outside lines of the section is divided among the forties in the quarter section adjacent to such line, each of the forties next to the line being allotted three (3) to each of the others one (1).

The cost of each half of the eight lines is divided equally among the four forties in which the half line lies.

Where the corners and quarter corners are all in and the various lines cost practically the same for surveying, this apportionment puts more of the cost on the outer forties than on those inside of the section, the apportionment being in the proportion of nine (9) for each of the forties contiguous to the center of the section, eleven (11) for each of the corner forties and ten (10) for each of the others.

Should any of the original corners or quarter corners be lost, a part of the cost of their re-establishment should be apportioned among all of the forties whose lines are dependent on such lost corner or quarter corner in proportion to the importance of such corner or quarter corner to the lines of each forty.

If required to establish the east quarter corner of a given section, the expense of running the east section line would be apportioned as follows:

One half of the cost of each half of the line would be divided equally between the forties adjacent to such half lines. The other halves, added together, would be apportioned to each forty of the section in proportion to the importance of such quarter corner to the E. and W. line or lines of each forty.

When a corner is to be re-established, the expense should be borne by the forties in the quarter section contiguous to such corner, unless it is necessary to use such corner in re-establishing

a lost quarter corner. In that case, a part of such expense should be divided among all the forties in proportion to the value of such corner and quarter corner to each forty.

The most vexatious problem in apportionment of cost of surveys is found when subdividing fractional sections along lakes or state or other boundaries. For the common fractional sections along the township and range lines the apportionment is made as for other sections, with due allowance for the greater or less length of the lines affected by the fraction.

For other fractional sections, no rule or table will be applicable to all cases. I use the method already described as far as possible, and for the rest am governed by the circumstances in each case.

One cannot, with fairness to all, entirely leave out of consideration the acreage in each fraction. Still, the size of a fraction does not necessarily affect the owner's share in the cost of the subdivision of the section.

The only rule to follow, generally, in apportioning the cost of surveying is to divide the cost of each line among all of the forties whose boundaries are dependent on such line, in proportion to the importance of such line to each forty.

Mr. Hodgman,—During the twenty-five years that I was County Surveyor, I tried many plans of apportioning the cost of surveys. That which gave best satisfaction was a rough approximation made on the ground at the time of the survey. The charges were figured only to the nearest quarter of a dollar. Each description, whether a quarter section, an eighty, or a forty, was charged according to the share of time and labor it took to survey it. In my surveys of that character, the owners always furnished the most, if not all, of the help. When the work was finished, they were called together and the cost apportioned. If all joined in the work, no account was taken of it. If some furnished more than their share of the labor, I deducted something from their bills and added it to the bills of those who furnished less. It was all talked over and adjusted equitably right there without unnecessary refinement. Some paid on the spot; others let it be returned in the taxes, but so far as I ever knew no one kicked on the apportionment.

ABOUT CORNERS OF WHICH THERE WAS LITTLE EVIDENCE.

B. F. DORR.

No. 1. The field notes said that the bearing trees for the ¼ post between 1 and 2 31 — 11, were a balsam, or fir, and a butternut. Parties told me it could not be found, and wanted me to establish one. In examining the location, I found a small balsam with the proper marks on it. When the U. S. surveyor marked it, he did not cut through the bark, and the marks did not show very plainly. The butternut called for proved to be a birch about four inches through, with the marks all overgrown.

No. 2. At the N. W. corner of Sec. 2, 32 — 12, the notes called for four (4) good-sized bearing trees. I found no trees there. I "run" and measured from N. E. corner to N. ¼ P., and continued, or prolonged the line the same distance. Within five links of the point thus obtained I found what appeared to be a stake hole. From this hole I found four rotten stumps — no marks on them — agreeing with the notes as to kind, size, course and distance, and I was as well satisfied as though the trees were standing, and the marks on them.

No. 3. When I came to the place where a certain ¼ post ought to be, I found a house and barn near by, and a man in the dooryard. I asked the man if he knew anything about the ¼ post. "Oh, yes!" he said, "I got him upstairs in mine house."

No. 4. At another ¼ post one of the bearing trees was a red oak. There were several low red oak stumps there. I asked the men who were there what was done with the tree that came from a certain stump. They said it was split into rails, and built into a fence near by. I looked along the fence a few rods and found a rail that had a scar on it. We got the rail out of the fence and split off the scar, and found ¼ S. on it. It was a rail from the butt of a tree, and we fitted it on to the stump. When so fitted, the marks faced in the right direction, thus identifying the bearing tree stump .

No. 5. At a certain corner the notes called for a basswood. A basswood stood there, but no axe mark on it, or other mark that you could see when standing near the tree. But when you were a rod away you could see the marks made by the marking iron. The tree had been marked on the bark when the tree was young, and the bark smooth. As the tree grew older, the bark became rough and broken.

No. 6. I was looking for a corner where one of the trees was said to be an elm. There was an elm stump near where I thought the corner ought to be. It was cut low, was hollow and full of water. I believed it was the bearing tree stump, but did not know how to prove it. I sat on a root of the stump, thinking and resting, and idly dabbling my hand in the water in the stump. There were chips in there. I pulled one out and that had the mark of a marking iron on it.

No. 7. Another time I found a birch bearing tree where the tree had been marked on the bark. A piece of bark with the marks on had fallen at the root of the tree.

No. 8. I "run" from the S. ¼ post of Sec. 4, 31 — 11, east one-half mile, and did not find the corner. Though I found a small tree with a notch made with an axe — near the root. The tree was lying down. The timber near this point was lying down and the land grown up to brush. Then I "run" from E. ¼ post of Sec. 9 north one-half mile, and came out ten rods too far east. The next morning my assistant and I were following out the first line run, and noticed that there were old blazes along near the line. When we got out to the little tree with a notch in it, we measured the course and distance from it called for, and found an old stake lying down, and at its point a very much older stake — very much decayed — and accepted it as the corner.

No. 9. Another time I "run" from the N. E. corner of a section, one-half mile south, and did not find anything. "Run" another half mile. Then went back a half mile and looked for ¼ post. It was in an open spruce swamp. There were spruce trees standing, and others lying down. Finally we found some old axe marks on a low stump; and there, lying down and under the moss, we found one of the bearing trees. Measuring from that the required

course and distance, we found such a mound as grows in such places, about three feet in diameter and one foot high. Under that mound, and on a level with the swamp we found the stake lying down.

No. 10. In Michigan I found a Norway pine one foot through, with not the least sign of an axe mark on it. I mistrusted that it was the bearing tree that I wanted. Cut into it three inches, and found the marks.

F. Hodgman,— I was surveying Sec. 5 T. 4 S. R. 9 W. in the winter of 1872. The South ¼ Sec. corner was said to be obliterated. It was in a north and south road. Residents claimed that the stake formerly stood in plain sight beside the wagon track and that a new stake had been driven beside the old one. They had disappeared and all agreed that some one had removed the stakes. The bearing trees were gone. The ground was frozen hard. Nothing was known of the Section corners east and west and bad swamps must be waded to reach them. So I set the men to digging where they all agreed the corner stake had stood. It was cold, hard work without result. While they were digging up the frozen soil, I was hunting about to see what I could find. One of the bearing trees was a very large maple 6 lks. south of the corner. I discovered a depression which looked as if the stump of such a tree might have been taken out from it. It was six or eight feet farther east than they were digging and a little south, when they gave up looking for the corner where they knew it had formerly been. Without my saying why, I stood on the north edge of the depression, estimated 6 lks. by my eye, pointed to the spot and told them to dig there. They said, "It is no use; we know it is not there." I insisted until one man took a grub hoe and began to dig in the sod. In less than a half dozen strokes he laid bare the two stakes just as they had been described. Some of those fellows have not ceased wondering yet how I, who had never been there before, could know more about the location of the corner than men who had been familiar with it for years. The wagon track had shifted, but the stump hole had not.

SOME TESTS OF STEAM RADIATORS.

J. C. Thorpe.

Honorable President and Gentlemen of the Michigan Engineering Society:

It may seem somewhat inconsistent for me to appear before you to present a paper on tests of radiators, at this time when we are watching our coal piles so zealously (if, indeed, we are so fortunate as to possess a coal pile), and when our eyes are all turned toward the anthracite fields, wondering what is to happen next. However, we may receive some inspiration that will enable us to figure out one or two hundredths of a British thermal unit more than we are coming in contact with these cold days. Indeed, like the poor bovine grazing in a meadow on the hottest day of which the oldest inhabitant has a memory, and which froze to death upon gazing into the adjoining field of popcorn, which the excessive heat had caused to cover the ground with snowy white kernels, we may be able to forget the scant coal supply, and the cold weather outside, while we consider what has been done to produce heat for warming our houses, offices and stores in times past when black diamonds were plenteous, and we were accustomed to toast our shins by our heaters and not have a care regarding the coal supply.

For a number of years the Mechanical Engineering Department of the University of Michigan has been engaged from time to time in making tests of steam radiators. These radiators were tested not always in the business interest of the radiator company, but often for the mutual benefit of the University and the company manufacturing the radiator, as, for instance, tests are made incidental to furnishing radiators for heating the new buildings erected from time to time on the University campus.

The condensing and radiating powers of the radiators are determined, and in considering the bids of different manufacturers, the results obtained in the tests are taken into account to determine just which radiator is the best one to install in view of the proposals. A comparison is thus made in dollars per B. T. U. radiated per square foot of actual radiating surface, in addition to the usual comparison of dollars per radiator, involved.

In 1891, a number of radiators were in question, and tests of these radiators occasioned the arrangement of the first apparatus for testing radiators at the University of Michigan. This plant was built and set up in the basement of the old Mechanical Engineering Laboratory, and in principle was the same as the apparatus now used, and which will be spoken of and described later. Although it was somewhat crude in construction, it served well the purpose of its erection. The apparatus was designed and its erection superintended by Prof. M. E. Cooley, your very worthy president. During that year, 1891, the tests were under the direction of Professor Cooley, and were conducted by Mr. Dwight Chiever, and were compiled in the thesis of the latter gentleman.

During these tests, the question arose as to the comparative values of the commercial rating of the radiators,—that is, the number of square feet of radiating surface per section. It was desired to know the ratio of the actual radiating surface as measured to the rated surface mentioned above. To determine this ratio, Professor Cooley undertook the task of measuring the actual radiating surface. Sheet-lead templates were made, and the surfaces worked out from the volume displacement in water. After many trials, the values were determined by averages and different methods, the final result being so closely determined as to check to the third decimal place; sufficiently accurate for all practical purposes, as you will admit, I am sure. Further, the ratios determined were nearly 100 per cent, showing a very reasonable commercial rating. This, I might say, is not always the rule, as results which will appear in the following data and which were obtained by the writer, have established values which were as low as 67 per cent, showing the radiator to be rated 33 per cent too high.

Results obtained with the apparatus used were quite satisfactory, but for future convenience and to permit of a few changes suggested by the experiences of two years, the old plant was torn down in 1893, when it was remodeled and erected in the attic of the Engineering Laboratory. This apparatus, the print of which appears, herewith, is still in almost constant use, and the results obtained are exceedingly satisfactory.

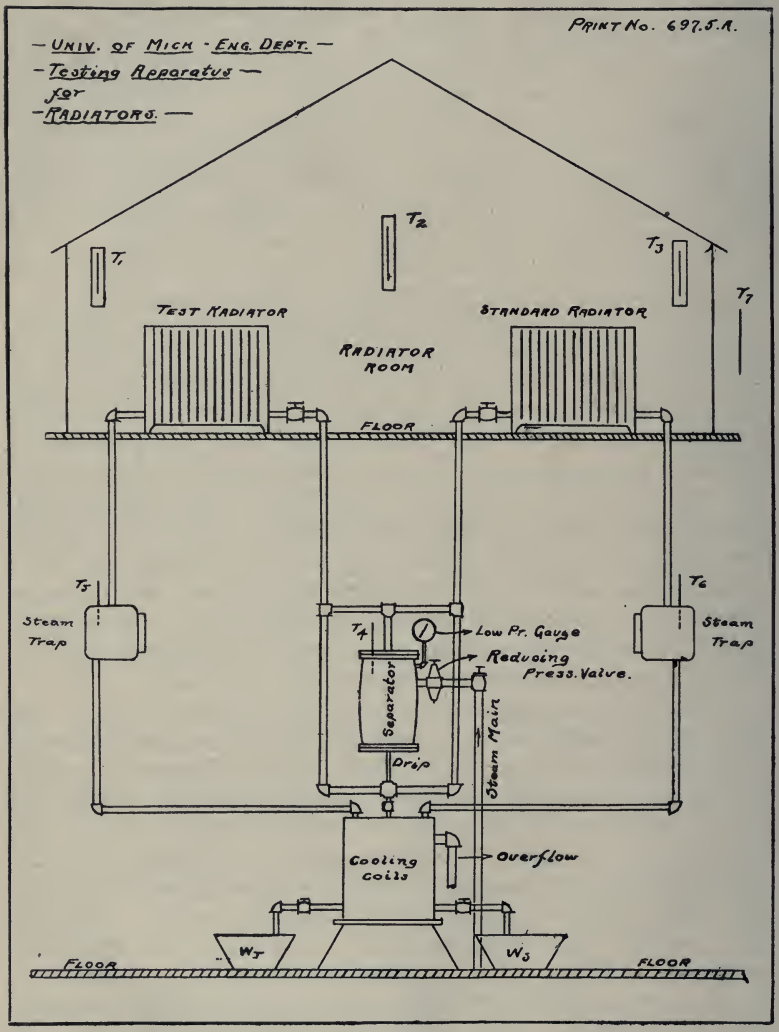
The room in which the new testing plant is erected, extends the full length of the upper story, or attic, of the laboratory, and is about 77 feet long by 36 feet wide, much of the space being

utilized as a storeroom for lumber and as a pattern loft for the wood-shop. The testing apparatus is erected near the center of this room, the roof of the building forming part of the walls of the radiator room proper, the floor of which is ten feet above the attic floor, and the plan dimensions of the room being 9 feet by 15 feet. The walls, which are six feet high, are built on three sides only, leaving the south side open. It is practically open above also, as the only roof or ceiling the room affords is the roof of the building itself. The arrangement is shown very clearly by the attached photographs, the radiator at the right being the standard, and the one at the left the one whose condensing power is to be determined.

The apparatus itself consists of the parts as shown on the accompanying blue print and sketch, print No. 637. 5A.

The live steam main M is piped directly from the University of Michigan boilers in the heating, lighting and power plant, 150 feet distant, the angle Valve V_1, is placed in the main M to change the direction of the pipe into the Heine eliminator E, and to afford a means of controlling the steam supply when this is necessary. A Curtis reducing pressure valve V_2 is placed in this length of pipe V_1, to E, for the purpose of reducing to, and automatically controlling the pressure of, the steam supply desired for the test. The Heine eliminator is fitted at D with a drip pipe, by means of which the moisture is drained from the separator and entrained moisture prevented from causing disturbances in the computations. A low-pressure gauge in connection with the eliminator indicates the actual pressure obtained during the test.

A pipe line is extended from the top of the eliminator through the radiator room floor to a convenient height, where it branches to the right and left, as shown in the sketch. Valves V_3 and V_4 are placed in these branch pipes, space being left for the placing of the radiators, the test radiators being placed in the position R^T and the standard or reference radiator in the position R^S. The outflow pipes pass from the radiators down through the floor into steam traps T′ and T″, from whence a smaller pipe leads to the coils in the cooling barrel B, from which the outlet pipes protrude. All this piping and the eliminator and trap are thoroughly covered with hair felt to reduce the error due to radiation and condensation. Thus, during the test, live steam from the main boiler supply is received through the pipe M, passing through reducing-pressure valve, where it is reduced to the desired pressure, varying from five to ten pounds per square inch, as shown


PRINT No. 697.S.A.
— UNIV. OF MICH - ENG. DEP'T. —
— Testing Apparatus —
for
— RADIATORS. —
T1
T2
T3
T7
TEST RADIATOR
STANDARD RADIATOR
RADIATOR ROOM
FLOOR
T5
T6
Steam Trap
Steam Trap
T4
Low Pr. Gauge
Reducing Press. Valve.
Separator
Drip
Steam Main
Cooling Coils
Overflow
W1
W2
FLOOR
FLOOR

on the gauge. The steam becomes saturated and even somewhat superheated in the eliminator, whence it passes to the radiators. The condensation collects in the traps T′ and T″, whence it passes to the cooling barrel and is drawn off into the weighing tubs W^T and W^S.

THE TEST.

Before beginning the test, steam is allowed to pass through the apparatus for a time, sufficient to insure thermal equilibrium. During this time the apparatus is inspected and all auxiliary apparatus, as the thermometers, tubs and scales, are put in place.

Preparations are made to take the following readings:

1. Number of the reading.
2. Barometer reading.
3. Time.
4. Temperature of external air T_7, obtained from a thermometer hung outside the window.
5. Steam pressure by low-pressure gauge.
6. Temperature T_4 of steam in eliminator, being the temperature of the saturated or superheated inlet steam to the radiators.
7. Temperature of condensed steam in traps T_5 and T_6.
8. Temperatures of air in radiator room; being T_1, T_2 and T_3. taken at three different points in the room, to insure a good average result for computation.
9. Weights of condensation, as obtained from the draining of the traps at each reading.

From the data thus obtained the following results are computed, as appear hereafter in the tests recorded, in addition to data and observations made as heretofore described.

Item 1. Size of radiator, giving the height, number of sections and number of columns.

2. Rated surface in square feet, as given by the manufacturer, or as is established for a new pattern after the surface is measured.
3. Actual measured surface in square feet.
4. Ratio; Item 3 to Item 4.
5. Weight of radiator in pounds.
6. Duration of test; the time of each test varying from one to four hours.
7. Atmosphere pressure; corresponding to the average of barometer readings taken before and after the test.

8. Average gauge pressure.

9. Corresponding absolute pressure.

10. Average temperature of entering steam, being the average of the readings T_4.

11. Temperature of steam, corresponding to pressure of Item 9, obtained from Peabody's tables of the properties of saturated steam.

12. Degrees superheat; being the difference between Items 10 and 11. This superheat ordinarily does not exceed one or two degrees, and is unimportant as regards the computations; however, it serves its purpose as an indication of dry steam.

13. Latent heat, corresponding to the absolute pressure, being the B. T. U.'s given up by the saturated steam during the condensation.

14. Average temperature of condensed steam; being the average temperatures, T_5 and T_6. This average should not vary greatly from the temperature T_4 of Item 11, or, if the steam is saturated, from Item 10.

15. Average temperature of radiator room; that is, the averages of T_1, T_2 and T_3.

16. Temperature difference between radiator room and entering steam. Item 11 — Item 15.

17. Average temperature of external air; *i. e.*, average T_7.

18. Condensation in pounds per hour; computed from readings 2 and 7.

19. Condensation per hour, per square foot of rated surface; computed from Items 2 and 17.

20. Condensation per hour, per square foot of actual measured surface; obtained from Items 17 and 3.

21. B. T. U. radiated per pound steam condensed; being the sum of Item 13 and the additional heat due to the superheat, if that, perchance, is of sufficient importance to be included.

22. B. T. U. radiated per hour; being the product of Item 18 into Item 21.

23. B. T. U. radiated per hour, per square foot of rated surface. Item 22 ÷ Item 2.

24. B. T. U. radiated per hour, per square foot of actual measured surface. Item 22 ÷ Item 3.

25. B. T. U.'s radiated per hour, per square foot of rated surface, per degree difference in temperature. Item 23 ÷ Item 16.

26. B. T. U.'s radiated per hour, per square foot actual measured surface, per degree difference in temperature. Item 24 ÷ Item 16.

27. Efficiency, rated.

28. Efficiency, actual.

It is very evident that Items 27 and 28 can only be relative, and in order that they be significant it is very necessary that one radiator be used as a standard of reference, whose performance — that is, whose condensing and radiating powers — has been definitely determined, under any and all desired conditions.

As this standard, a 12-section, double-column, 38″ radiator is used at the University of Michigan. A very great number of tests have been made, and accurate results obtained, with a view to establishing the definite values mentioned above. Thus, in our tests, Items 27 and 28 refer to the efficiencies as compared with the University of Michigan standard, whose efficiency is arbitrarily assumed as 100 per cent.

It will be seen, also, that these values established for the standard radiator serve as a valuable check on the experimental results obtained in any individual test.

It might be well to state, also, that all instruments, as thermometers, gauges, scales, etc., are carefully calibrated by comparison with the University standards, thus eliminating any error that might creep into the computations, on account of the inaccurate graduations.

Below will be given the results of the tests made to establish values for the University of Michigan standard and of others.

Tests of 1891 by D. B. Cheever, under the direction of Prof. M. E. Cooley.
Tests conducted on the old testing plant.

		I.	II.	III.	IV.
1.	Radiator	U. of M. Standard	U. of M. Standard	A	A
2.	Size	12s. 2c. 38″	do	.....	.....
3.	Radiated Surface	43	do	52.2	52.2
4.	Actual Surface	46.56	do	51.04	51.04
5.	Ratio, 4 to B	47 per cent	do	97.7	97.7
6.	Weight in pounds	317.5	do	.....	.....
7.	Duration of test	2 hrs.	2 hrs.	2 hrs.	2 hrs.
8.	Barometer reading	29.0″	29.2	29.12	29.12
9.	Atmospheric pressure	14.30	14.4	14.36	14.36
10.	Gauge pressure	3.70	15.7	3 7	15.7
11.	Corresponding absolute pressure, P	18.0	30.1	18.06	30.06
12.	Observed temperature of entering steam	225.9	253.9	226	254
13.	Temperature corresponding to P., obtained from tables	224.4	250.3	222.6	250.4
14.	Super heat, degrees	3.5	3.6	3.4	3.6
15.	Latent heat corresponding to P	958.5	940	959	940
16.	Temperature of condensed steam T5, T6	222	252	.....	.....
17.	Temperature of radiator room	67	67	68	65
18.	Temperature difference	155.4	184	157	186
19.	Temperature of external air	47	46	45	45
20.	Condensation per hour, lbs	12.5	15.72	12.5	16.6
21.	Condensation per hour, lbs., per square foot rated surface	.264	.335	.225	.315
22.	Condensation per hour, lbs., per square foot actual surface	.268	.337	.....	.....
23.	B. T. U's. radiated per pound of steam	960.3	941.8	960.7	941.8
24.	B. T. U's. radiated per hour	12003.8	14786	12008.8	15634
25.	B. T. U's. radiated per hour per square foot rated surface	253.56	315.8	219.9	299.9
26.	B. T. U's. radiated per hour per square foot actual surface	.....	.....	.....	.....
27.	B. T. U's. radiated per hour per square foot rated surface per degree temperature difference	1.631	1.712	1.34	1.61
28.	B. T. U's. radiated per hour per square foot actual surface per degree temperature difference	.....	.....	.....	.....
29.	Efficiency, rated	100	100	87.5	99.4
30.	Efficiency, actual	.....	.....	.....	.....

These results were obtained as averages of eight tests of the Perfection, and are sufficiently accurate to establish reference values under these conditions for the radiator in question. To the tests of the University of Michigan standard and the *radiator A* were attached the most importance, perhaps, of any tests made on the original plant.

Subsequently, however, tests were made on wrought-iron tube radiators, which were quite satisfactory, an efficiency based on the rated surface being obtained of over 100 per cent, the University of Michigan standard being used as a reference at this time.

We will now take up for our consideration tests of different types and styles of radiators, and endeavor to determine something of the effect the change of form or construction has upon the radiator performance. Four tube radiators were obtained for test, consisting of sections of one, two, three and four tubes. Tests of these radiators, B, C, D, and E, gave results as follows:

DATA AND RESULTS.

	B	U. of M.	C	U. of M.	D	U. of M.	E	U. of M.
1. Radiator	12s. 1c. 38″	12s. 2c. 36″	42 tubes	12s. 2c. 38″	12s. 3t. 38″	12s. 2c. 38″	12s. 4t. 38″	12s. 2c. 38″
2. Size	12	48	42	48	48	48	48	48
3. Rated Surface	12.12	46.56	38.11	46.56	43.44	46.56	43.22	46.56
4. Actual measured surface	1.01	.97	90.7	97	90.5%	97	89.6	97
5. Ratio, 4 to 3	79.0	317.5	217.8	317.5	216.15	317.5	.....	317.5
6. Weight, in pounds								
7. Duration of test	2 hrs.	.....	4 hrs.	.....	2½ hrs.	.....	2½ hrs.	2½ hrs.
8. Barometer reading	28.97	.....	29 01	.....	29.14	.....	29.1	.....
9. Atmospheric pressure	14.22	.....	14.24	.....	14.3	.....	14.3	.....
10. Gauge pressure	3.4	.....	3.46	.....	4.65	.....	4.67	.....
11. Absolute pressure, P	17.62	.....	17.7	.....	18.95	.....	18.97	.....
12. Observed temperature entering steam	234.3	.....	244.60	.....	247.8	.....	243.7	.....
13. Temperature corresponding to P.(tab.)	221.2	.....	221.47	.....	225.1	.....	226.8	.....
14. Super heat, degrees	13.1	.....	23.13	.....	22.7	.....	16 9	.....
15. Latent heat corresponding to P	959.16	.....	958.98	.....	956.4	.....	956.	.....
16. Temperature of condensed steam	222.77	222.4	223.9	223.4	223.	223.5	224.1	224.6
17. Temperature of radiator room	89.7	.....	83.3	.....	74.3	.....	73.07	.....
18. Temperature difference	.....	131.53	138.2	.....	150.75	.....	152.8	.....
19. Temperature of external air	75.8	.....	69.2	.....	29.4	.....	23.2	.....
20. Condensation per hour, lbs.	5.36	10.665	11.95	11.4	13.23	12.22	9.7	12.51
21. Condensation per hour, lbs., per square foot radiated surface	.446	.222	.284	.237	.275	.254	.202	.261
22. Condensation per hour, lbs., per square foot actual surface	.442	.229	.313	.244	.304	.262	.224	.268
23. B. T. U's. radiated per pound steam	965.43		970.1	.....	967.3	.....	963.4	.....
24. B. T. U's. radiated per hour	5173.7	10296.3	11589.8	11054.3	12797.6	11820.6	9350.5	12051.7
25. B. T. U's. radiated per hour per square foot rated surface	431.2	214.5	275.9	230 3	266.6	246.3	194.8	251.1
26. B. T. U's. per sqnare foot actual surface	426.9	221.1	304.1	237.4	294.6	253.9	216.3	258.8
27. B. T. U's. radiated per hour per square foot rated surface per degree temperature difference	3.27	1.63	1.99	1 66	1.77	1.63	1.27	1.64
28. B. T. U's. per square foot actual surface	3.26	1.68	2.20	1.72	1.96	1.68	1.41	1.69
29. Efficiency, rated	200 per cent	100	119 per cent	100	108 per cent	100	77 per cent	100
30. Actual efficiency	194 per cent	100	128 per cent	100	116 per cent	100	83 per cent	100

Now, for convenience of comparison, we will summarize the results obtained, using as a basis the B. T. U.'s radiated per degree difference in temperature, per sq. ft. of actual measured surface.

1.	Single tube radiator B	3.26	B. T. U.
2.	Double tube " C	2.20	"
3.	Three tube " D	1.96	"
4.	Four tube " E	1.41	"
5.	U. of M. standard	about 164	"

From these tests and their comparison, we have determined that the condensing and radiating power per square foot varies inversely as the number of columns in a section. We are also justified in the assumption that if the columns per section exceed three in number, the interior columns do not add proportionately to the condensation of the radiator.

From these and similar tests, the data of which I will not take time to present to you to-night, the following conclusions regarding radiator performance have been reached:

First — That the radiation per square foot varies inversely as the number of columns per section.

Second — That the radiation per square foot does not necessarily vary with a change in volume, except in so far as this change obstructs the passage of steam.

Third — That the radiator performance is not essentially changed by a change in the materials of construction, provided the tests are made under exactly similar conditions.

Gentlemen, I thank you for your patience.

SOME QUESTIONS IN LAND SURVEYING.

F. HODGMAN,

Chairman of Committee No. 5.

THERE are very few questions in practical land surveying that have not been discussed by this society, and the answers given, to our own satisfaction at least. They can all be found in my manual of land surveying, and in the various volumes of the proceedings of the society.

But as men disappear from the scene and new men appear, the old questions keep bobbing up anew. One of the oldest of these question which has recently come up for an airing, is how to locate the center of a section. Unfortunately for young surveyors, the most of the text-books on surveying have been written by men whose writings do not show that they had any intimate practical knowledge of surveying under the United States land system. Of ten text-books in my possession, only three have anything to say on the subject, and those three only give what is to be found in the United States Manual of Instructions. And yet eighty per cent or more of the surveys in the United States are made under that system.

A few months since, a Mr. Kern, of Philadelphia, prepared and had copyrighted a paper which was published in *Engineering News* of August 28, 1902, in which he gives the following in regard to locating the center of the section:

"Two methods have been mentioned for finding the center of a section. The pamphlet issued by the general land office in 1885 entitled 'Restoration of Lost and Obliterated Corners,' suggests that it be placed at the inter-section of lines run from the opposite quarter corners. Another method was to place it at a point equidistant from the quarter corners, except in the north and west tiers of sections, where it would be located as described above for section corners, using the quarters as a basis. From a legal standpoint, the following would probably be preferable:

"When completely marked, the exterior of a section has eight monuments. From carelessness, these frequently disagree with

the field notes. Quarters are often out of line and nearer one corner than the other. In spite of these defects, when set the marks must not be altered in position. Again, fractional subdivisions are described as 'quarter sections,' indicating the idea of quantity, hence a quarter section should be surveyed as one-fourth of the area of the section as physically defined. This should be done by first making a careful survey of the entire section and calculating its actual area. A point should then be fixed so that lines run from it to the quarter corners east, west and south would include exactly one-fourth of the entire calculated area. This would determine a boundary for the S. E. and S. W. ¼s. A second point on the line between the E. and W. quarters at such position, that a line drawn from it to the quarter corner north would divide the north ½ equally, should then be fixed. The section might then have two centers, as it were, but usually one point would answer the requirements. Fig. 1 will

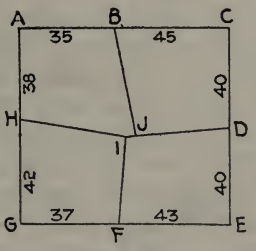


Fig. 1

illustrate a possible condition. Suppose the field notes show a section 80 x 80, with quarter corners all 40 chains from the section corners, and a measurement shows an area of 640 acres, but the quarter corners at incorrect distances as indicated. A point I is found by calculation, so that by joining H I, F I and D I the S. E. and S. W. ¼s. are each 160 acres. A second point J is found, so that by joining B J the N. E. and N. W. ¼s. are equal to each other and the other two. The patentee of the N. W. ¼ cannot complain at his irregular lines, as he receives more land than by running straight lines between the ¼ corners, as indicated by the land office circular."

I called his attention to the fact that the method he criticised was the law of the land, and not simply a suggestion of the land commissioner, and that his (Mr. Kern's) method was not in harmony with the statute. He responded by saying:

"Commenting upon Mr. Hodgman's criticism of my method of subdividing a section (*Eng. News,* Sept. 4, p. 170), I think he will find himself mistaken in saying that the method criticised is not in harmony with the statute. The act of Feb. 11, 1805, is contained in Sec. 2966, U. S. Rev. Stat., p. 439, and is there divided into several subsections. The first article directs that all corners not marked shall be found by running a line between the nearest corners on the same line and proportioning the distance. The second article provides for running lines between opposite quarter corners, and fixing their intersection as the true center. A little study will show this and the first method to be susceptible of possible disagreement. The third section states that fractions of section shall be taken to be 'as containing the ½ of ¼ part, respectively, of the returned contents of the section,' etc. This is the clause upon which I base the method of subdivision criticized, and which method is therefore in harmony with both the statute and common law.

"But without this former Secretary Teller, in his letter of instructions to state and county surveyors, March 13, 1883, at pp. 12 and 13, states that after the land has been patented, 'the United States having no longer any authority to order any changes when the lands affected by such corner have been disposed of,' the matter must be left to the state courts, which, of course, enforce the common law."

To which I made the following reply:

"Section 2396 of the revised statutes of the United States starts out as follows:

"'The boundaries and contents of the several sections, half-sections and quarter-sections of the public lands shall be ascertained in conformity with the following principles.'

"Then follow the principles, one of which is:

"'The boundary lines which have not been actually run and marked, shall be ascertained by running *straight lines* from the established corners to the opposite corresponding corners.'

"How lines having angles and jogs in them, as proposed by Mr. Kern in your issue of Aug. 28, can be in conformity with that principle, I am too dull to comprehend.

"Commissioner Wilson, of the General Land Office, said (Dunn's Land Laws, p. 19):

"'The manner of subdivision consists of measuring *straight lines* from quarter-section corners of a particular section to the opposite corresponding corners and the point of the intersection is the interior corner common to four quarter-sections.'

"I can understand that method to be in conformity with the principle laid down in the law. But to justify a different method we are referred to clause third of the same section of the statute, in which it is said:

"'The half-sections and quarter-sections, the contents whereof shall not have been thus returned, *shall be held and considered* as containing the one-half or the one-fourth part respectively of the returned contents of the section, etc.'"

"As it looks to me, if Congress had intended to override and abrogate the principle which it had previously laid down, it would have said plainly these half and quarter-sections *shall contain* the one-half or the one-fourth part, etc. But it did nothing of the sort. Just as it said in regard to measures in clause second, 'the length of such lines as returned shall be held and considered the true length thereof,' so, in clause third, it says these half and quarter-sections '*shall be held and considered as containing* the one-half or the one-fourth part,' etc. That is in harmony with the rest of the act and a very different thing from saying they *shall contain* such a part of the section. The whole act shows evidence of the design of Congress to supersede the common law rule in fixing the boundaries of half and quarter-sections, otherwise it would have said nothing about it. There would have been no need to require us to 'hold and consider.' But Mr. Kern tells us that after all it is for the state courts to settle, and that they follow the common law rule. I question the correctness of the latter part of this statement. So far as my reading goes, it is the rare exception for a state court to uphold a different method of subdividing a section from that provided in the statute under which the land-holders acquired their rights.

"According to such light as I have had, it is not even good common law, where landed rights have been acquired under the

provisions of and in accordance with the statute, for the common law thereafter to step in and attempt to vary those rights."

That ended the discussion.

Question 2.—"Section 3 is fractional on Grand Traverse Bay, the center being a few rods out in the bay. How shall the quarter lines be run?" See Figure 2.

Fig 2

Answer.—As Section 3 is fractional in the north half, run the east and west quarter-line parallel with the south line of the section. Run the north and south quarter-line parallel with the west line of the section. The field notes were not given with the question. A full knowledge of what they contain might show reason for modifying the answer.

Question 3.—"How much variation shall I allow for a period of, say 24 years, in the notes of the survey of an angling road of many courses, which are as follows," etc.?

Answer.—I cannot tell. The annual change of declination approximates 4′ in Michigan. If you can definitely locate any two points of the original survey of the road, you can run a random line between them, and find the exact variation to allow. For methods of doing this where more than one course has to be run, see my Manual of Land Surveying, page 79, and the paper entitled, "That Problem in Land Surveying," in the Michigan Engineers' Annual for 1891, page 36. If there are not two known points of the original survey of the road, you had better not try to relocate the original line by surveys. It cannot be done with any certainty, because you have no means

of comparing your compass and chain, or transit and tape, with that used on the original survey. Better make a relocation of the road in accordance with actual occupation, or such other location as may be asked for by the parties interested.

Question 4.—A sells land to B, described as 30 acres off the west side of Lot 1 of the section. Figure 3 represents Lot 1 as shown on the official plat. A's intention was to sell 30 acres, and have a strip left. Does the surveyor take the government returns for it, or does he have to run it out following the meander lines, and then part off all but the 30 acres, be it more or less? If the land actually measured only 30 acres, would B be entitled to the whole of it or only his proportion of 33.60 acres?

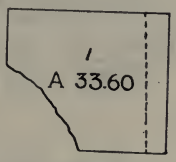


Fig. 3

Answer.—A's intention cuts no figure in the case, unless it was understood and shared in by B. If there was a mutual understanding and agreement between the parties, it would guide the surveyor in locating the line. In the absence of evidence as to the mutual intent of the parties, B is entitled to his proportion of the lot, as shown by the official plat. It has been decided by the supreme court of Michigan that in such cases the government meander line is to be used in making the computation.

Question 5.—Since the original survey of Section 9, the Mississippi River has changed its course, adding by accretion nearly an entire section in Section 16. Parties wish to purchase the newly made land in that section from the government. How shall I survey it? The field notes show that the line between Sections 9 and 16 was run, and meander posts and quarter post established.

Answer.— The United States owns no land there if it has sold the lots in Section 9 bordering on the river. The official plat does not show any Section 16, but it does show that the outlying

fractions, which would otherwise have constituted a fractional Section 16, were attached to the lots in Section 9. Any accretions which have formed against those lots belong to the owners of the lots.

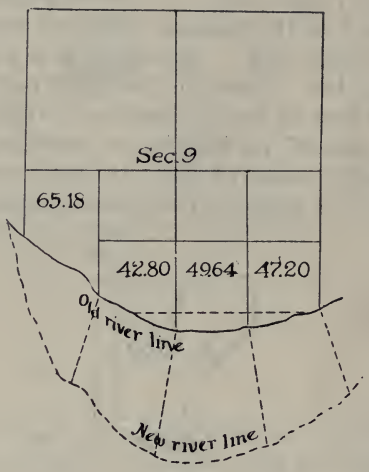


Fig. 4

To locate the boundaries of the lots on the accretion, relocate the old river line as far as the change extends, and mark the points where it is intersected by the lot lines as shown on the official plat. Lots on other sections as far as the accretion extends must be taken into the account. Measure the amount of the old shore line which each lot has. Then measure the new shore line and assign to each lot the same proportion of the new shore line that it has of the old, and connect the corresponding points on the two shore lines by straight lines.

A strict carrying out of the principles involved would call for curved lines to correspond with the changing contours as the river receded, but this is hardly practicable, and is not required by the courts.

RECENT LEGAL DECISIONS.

BOUNDARIES.

1 **(Pa. Super. Ct. 1901)**

Where there is a conflict between the monuments, either natural or artificial, and the courses and distances named in a deed, the former must control.— Richardson v. City of McKeesport, 18 Pa. Super. Ct. 199.

2 **(Ky. 1902)**

The rule that courses and distances must give way to natural objects will not be applied where the natural object is not clearly identified, and where it would cause a departure from other natural objects called for in the patent.— Bell County Land & Coal Co. v. Hendrickson, 68 S. W. 842.

3 **(Cal. 1902)**

A judgment in ejectment, granting plaintiff possession of land "bounded on the north by the north boundary of the S. ½ of the N. E. ¼" of a certain described section, "on the east by the east boundary" of the section, and "on the south and west by the fence of defendant; containing about 10.62 acres,"— requires the relinquishment of the tract described by the boundaries, and not a tract of but 10.62 acres, under Code Civ. Proc. § 2077, providing that, where there are certain definite and ascertained particulars in the description, the addition of others which are indefinite, unknown or false does not frustrate the conveyance, which is to be construed by the particulars; and, when permanent and visible or ascertained boundaries or monuments are inconsistent with the measurement, the boundaries or monuments are paramount.— Dutra v. Pereira, 67 P. 281.

4 **(S. D. 1902)**

Where a section line is in controversy, it is the duty of the court to ascertain, if possible, the line as indicated by monuments and mounds established by the government surveyor, and such lines, when discovered, must prevail.— McGray v. Monarch Elevator Co., 91 N. W. 457.

5 (Tex. Civ. App. 1902)

Where there is no ambiguity on the face of a deed which calls for marked corners found on the ground, but the course and distance of one of the lines do not correspond with such corners, the line must run straight between the corners.— Sloan v. King, 69 S. W. 541.

6 (Wis. 1902)

Undisputed evidence that the fence bounding plaintiff's lots had been built while the original survey stakes were standing, and that later it had been observed to correspond with at least one of the stakes, sufficiently showed the fence to be on the true line as run and marked on the original survey, and was not overcome by evidence of measurements not shown to have started with, nor to have followed, any points known to have been fixed on the survey.— Gilman v. Brown, 91 N. W. 227.

7 (Me. 1902)

Where lots have been granted by numbers according to a plan referred to, which has resulted from a survey actually made and marked on the ground, the lines and corners fixed by that survey determine the extent and bounds of the respective lots; and where the deed also gives the boundaries of the lots, and the bounds so given are precisely the same as those appearing upon the plan referred to, the lines and surveys fixed by the plan govern, though there are unidentified stakes on the ground not corresponding with the survey.— Coleman v. Lord, 52 A. 645, 96 Me. 192.

8 (Wis. 1902)

Where a boundary fence was built on what the parties supposed was the true line, and there was no dispute, and it was not known that there was any uncertainty, an establishment of the boundary by implied contract and acquiescence, so as to estop the parties, was not shown, and hence no title could be claimed on a possession of less than twenty years.— Peters v. Reichenbach, 90 N. W. 184.

9 (Iowa, 1902)

Where, in an action under the Code, to settle a disputed boundary line, the commissioner reports that he could not fix the

line without locating a certain section corner, and that he did locate such corner, but his report as to such location was not confirmed, because the parties interested therein were not parties to the action, location made by him was sufficient as a point from which to measure in locating the boundary disputed in the action.— Newton v. Templeman, 89 N. W. 24.

10 (Mo. 1901)

Where owners of adjoining tracts of land had a controversy with reference to the division line, and employed a surveyor, who ran a line which both subsequently acquiesced in by constructing a fence thereon and cultivating up to it, without reference to what was the true line, there was an agreement as to the boundary, conferring title on each up to the line as fixed, independently of the statute of limitations.— Barnes v. Allison, 65 S. W. 781.

11 (Mo. 1901)

Where owners of adjoining tracts of land had a survey made to fix a disputed boundary, and agreed to the boundary as thereby established, the fact that a boundary fence departed at one end from the line as established, to accommodate itself to a creek, did not show disregard of the agreed line, nor that the fence and not the line, was regarded as the boundary.— Barnes v. Allison, 65 S. W. 781.

12 (Ky. 1902)

The actual location of a line controls, and, though a deed calls for a straight line between two points, if the line is in fact located and marked as a crooked line, the latter controls; the actual location of the line being a question for the jury, under all of the evidence.— Johnson v. Harris, 68 S. W. 844.

13 (Mich. 1902)

Where there is a shortage in the actual land platted into lots and blocks with intervening streets, each block should, if possible, be treated as distinct, and the shortage therein be distributed among the lot owners, except so far as possession has fixed the limits. — Anderson v. Wirth, 91 N. W. 157, 9 Detroit Leg. N. 254.

14 **(Neb. 1902)**

The grant of land on a non-navigable river, made by the general government with reference to the plat of the survey, which shows a meandered line along the river bank, conveys to the grantee such unsurveyed islands or parts of islands as lie within that limit.— McBride v. Whitaker, 90 N. W. 966.

15 **(Neb. 1902)**

Grants of land on a non-navigable river carry with them the exclusive right and title of the grantee to the center of the stream, unless the terms of the grant denote the intention to stop at a margin of the river.— McBride v. Whitaker, 90 N. W. 966.

16 **(Tenn. 1902)**

Where a stream which is navigable not in the legal, but only in the ordinary, sense, is a boundary of lands, the title extends to the center of the stream, unless an intention to exclude the land between the bank and the thread of the stream is clearly expressed in the deed.— Webster v. Harris, 69 S. W. 782.

17 **(Tenn. 1902)**

Where a deed expressly calls for low-water mark of a non-navigable stream as one of its boundaries, the rule that a grant bounded by a non-navigable stream will extend to the center of the stream cannot apply.— Webster v. Harris, 69 S. W. 782.

18 **(La. 1902)**

The thread of a stream is the line midway between the banks at the ordinary stage of water, without regard to the channel, or the lowest and deepest part of the stream.— State v. Burton, 31 So. 291, 106 La. 732.

19 **(La. 1902)**

Between nations or states the thread of a boundary river is the line of separation, without reference to the track of navigation.— State v. Burton, 31 So. 291, 106 La. 732.

20 **(Ohio, C. C. 1902)**

The land under the water of a navigable stream is not included in the measurement of the abutting lot, but title to it

passes to the center of the stream with the conveyance of the lot, and it is not necessary to include it in the measurement.— Chesbrough v. Head, 23 Ohio Cir. Ct. R. 427.

21 **(U. S. C. C., N. Y. 1902)**

The inshore boundary of a grant of a strip of land below high-water mark, four hundred feet wide, changes with the high-water mark, the shifting of the shore being from natural causes. — De Lancey v. Wellbrock, 113 F. 103.

22 **(Mich. 1902)**

Plaintiff and defendant purchased a tax title to the lot in controversy, which was bounded on the east by a lake, and which had been meandered, and was shown by the government survey to contain 64.40 acres. The title was taken in plaintiff's name. Thereafter plaintiff quit-claimed an undivided one-half thereof to defendant, excepting 2.46 acres sold to third persons; the deed reciting that it was understood the parties should divide the property equally: plaintiff to have the south, and defendant the north, half; the division to be made by voluntary conveyances to be thereafter executed. Afterward a deed to the entire lot was obtained by the parties from the holder of the original title, and plaintiff deeded the north 31 acres to defendant; and defendant, the entire lot to plaintiff, "lying south of the north 31 acres," excepting the 2.46 acres already sold; each deed reciting that it was made to carry out the agreement specified in the quit-claim deed. *Held,* that, in order to determine the south boundary of the north 31 acres so conveyed to defendant, the land should be measured to the meandered line of the lake, and not to the water's edge; such measurement carrying out the parties' expressed intention of dividing the property equally. — Peck v. Webb, 88 N. W. 888, 8 Detroit Leg. N. 975.

23 **(Iowa, 1902)**

Plaintiff derived title from the government to two lots of land, situated in the south half of a certain section; the south line of the section being the southern boundary, and the northern boundary being indicated by a meander line. In fact, there was water north and in the vicinity of the lots; but there was a large tract of unsurveyed swamp land, of which about two hundred acres lay within such half section, north of plaintiff's lots, which

he claimed, on the theory that the half-section line, instead of the meander line, was his northern boundary. In 1898, the government surveyed this swamp land, and conveyed it to the state, pursuant to the swamp land grant of 1850. *Held,* that where, as in this case, there was no water to be meandered, the rules relating to riparian owners could not apply, and the meander line becomes a boundary, beyond which plaintiff's title did not extend.— Schlosser v. Hemphill, 90 N. W. 842.

24 **(Minn. 1902)**

Where the boundaries of fractional lots appear by the government plat to abut on a body of water, which, in fact, never existed substantially at the place indicated in the plat, a supposed meander line will, if consistent with the other calls and distances, mark the limits of the survey, and be held to be the boundary line of the land it delimits.— Security Land & Exploration Co. v. Burns, 91 N. W. 304; Same v. Weckey, *Id.*

25 **(Neb. 1902)**

Where government corners are not found, one desiring to establish the corners at places different from those called for by the field notes of the government survey has the burden of proof. — Knoll v. Randolph, 92 N. W. 195.

26 **(Neb. 1902)**

Government corners, fixed by a United States surveyor, will control the field notes of the survey taken at the time the corners were erected, and also the field notes of any subsequent survey. — Knoll v. Randolph, 92 N. W. 195.

27 **(Neb. 1902)**

In the absence of a government corner, or of satisfactory proof of its location, the field notes of a government survey will govern, and are *prima facie* evidence of the true location of the true line of the survey.— Knoll v. Randolph, 92 N. W. 195.

28 **(N. Y. Sup. 1902)**

A deed of land described as on the easterly side of the highway, beginning at a locust stake driven in the ground, thence along said highway a certain distance, thence by courses and distances, and returning a specified number of feet to the highway

aforesaid to the point of beginning, and likewise a deed of land described as on the north side of the highway, beginning at a locust stake, and running along the northerly side of the highway a certain distance, and thence by courses and distances, returning a certain number of feet to the place of beginning, excludes the highway from the land granted. — Kennedy v. Mineola, H. & F. Traction Co., 78 N. Y. S. 937.

29 (Mo. 1902)

The fact that he has conformed to an erroneous line, believing it to be the true one, will not prevent an adjoining landowner from claiming to the true boundary line whenever it is ascertained. — Patton v. Smith, 71 S. W. 187.

30 (N. Y. Sup. 1902)

The fact that the original patent to land bounded the premises on the west by a street did not preclude the patentee and his successors from claiming title to the center of such street, it being presumed that a grant by the state of land bordering on a highway conveys title to the center thereof. Order, Lansing v. Schenectady Ry. Co., 77 N. Y. S. 889, 38 Misc. Rep. 384; Van Epps v. Same, *Id.;* Whitmyre v. Same, *Id.;* Beattie v. Same, *Id.;* Thompson v. Same, *Id.;* Vrooman v. Same, *Id.,* reversed.— Paige v. Schenectady Ry. Co., 79 N. Y. S. 266.

DEEDS.

1 (Me. 1902)

In construing a grant, effect is to be given, if possible, to the intent of the parties.— Proctor v. Maine Cent. R. Co., 52 A. 933, 96 Me. 458.

2 (Me. 1902)

Ordinarily the intent which is effective in a grant is the intent expressed in its language, and is to be ascertained by giving suitable effect to all the words of the grant, read in the light of the circumstances attending the transaction, the situation of the parties, and the state of the country and of the estate granted.— Proctor v. Maine Cent. R. Co., 52 A. 933, 96 Me. 458.

3 **(Va. 1902)**

The construction of a deed and a written agreement is for the court and not for the jury.— New River Mineral Co. v. Painter, 42 S. E. 300.

4 **(Pa. Super. Ct. 1901)**

Designation in a deed of property conveyed by lot numbers, and an express reference to a plan showing the lots and their numbers, make the plan an essential part of the deed, and have the same force and effect as if the plan had been copied into the conveyance.— Richardson v. City of McKeesport, 18 Pa. Super. Ct. 199.

5 **(La. 1902)**

In the description of property in a deed according to the maps of the United States survey, an error in the number of the range is immaterial where the description otherwise identifies the property.— Willis v. Ruddock Cypress Co., 32 So. 386, 108 La. 255; *In re* Willis, *Id.*

6 **(Wash. 1902)**

A description in a deed of certain lots in "block C of ——— addition" to a certain city did not convey "block D in Depot addition."— Briggs v. Murray, 69 P. 765.

7 **(Neb. 1901)**

Where the official plat of the survey of government lands shows a river as one boundary of a certain lot, a subsequent patent for the lot, describing it by number, and referring to the plat, on which it is marked as containing a certain amount, and deeds describing the lot by number, pass all accretions to the lot up to their respective dates.— De Long v. Olsen, 88 N. W. 512.

8 **(Ill. 1902)**

Where a deed contained two distinct descriptions of land, each of which is complete,—(1) "thirty-six acres off the north end of lot No. 2;" (2) "being 18½ chains' width across the north end of said lot No. 2,"— and the descriptions conflicted, that by metes and bounds controlled the one by quantity.— Seeders v. Shaw, 65 N. E. 643, 200 Ill. 93.

DRAINS.

1 (Mich. 1902)

A township owning no land as a municipality cannot maintain a bill in behalf of certain landowners to enjoin completion of a drain.— Swan Creek Tp. v. Brown, 90 N. W. 38, 9 Detroit Leg. N. 52.

2 (Mich. 1902)

The finding of the special commissioners or of a jury appointed under the statute on the question of the necessity of a drain is as conclusive on the courts as is the verdict of a jury on conflicting evidence.— Swan Creek Tp. v. Brown, 90 N. W. 38, 9 Detroit Leg. N. 52.

3 (Mich. 1902)

The courts have no power to enjoin the completion of a drain on the theory that it is to the injury of the public health, as the power to determine such question is placed exclusively with the tribunals established for determining the questions of necessity and of eminent domain.— Swan Creek Tp. v. Brown, 90 N. W. 38, 9 Detroit Leg. N. 52.

4 (Mich. 1902)

Where application was filed with the county drain commissioner on June 20, 1899, and his opinion that the drain was necessary was filed February 2, 1900, and different proceedings were had, and money expended, without objection, until October, 1900, when a bill was filed to restrain completion of the drain, the plaintiffs were guilty of laches, and could not object to defects in the proceedings, as Comp. Laws, § 4346, gives a remedy, in case of defects, by certiorari, and requires it to be brought within ten days.— Swan Creek Tp. v. Brown, 90 N. W. 38, 9 Detroit Leg. N. 52.

5 (Mich. 1902)

A complainant who does not allege in his bill nor show by his testimony that his land is injured cannot maintain a bill to enjoin the completion of a drain.— Swan Creek Tp. v. Brown, 90 N. W. 38, 9 Detroit Leg. N. 52.

6 (Mich. 1902)

Under a statute providing that notice of certiorari shall be served on a drain commissioner within ten days after his determination, and, if not so served, the legality of such determination shall not be questioned thereafter, an application for certiorari made over two months after such determination was made comes too late.— Blumfield Tp. v. Brown, 90 N. W. 284, 9 Detroit Leg. N. 120.

7 (Mich. 1902)

Pub. Acts 1899, Act No. 272, p. 464, § 1, provides that, on the review of the assessment of the county drain commissioner, the supervisor of a township may appear in its behalf. § 2 declares that any township, considering itself aggrieved by the assessment for a county drain, may appeal within ten days after the review thereof provided for in § 1, and that the supervisor of any township desiring to take such appeal shall apply to the probate court for the appointment of a board of review. Comp. Laws, § 2336, enacts that the supervisor of a township shall be the agent for his township for the transaction of all legal business. *Held,* that the supervisor could appeal from the assessment of the drain commissioner without awaiting authorization from his township.— Long v. Ionia Probate Judge, 89 N. W. 938, 9 Detroit Leg. N. 22.

MISCELLANEOUS.

1 (U. S. C. C. A., Cal. 1901)

The federal courts are without jurisdiction to entertain a suit to determine the respective rights of the parties in land the title to which remains in the United States, and in regard to which a contest between the parties is pending in the land department. Judgment (C. C. 1900) 104 F. 20, affirmed.— Cosmos Exploration Co. v. Gray Eagle Oil Co., 112 F. 4; Pacific Land & Improvement Co. v. Elwood Oil Co., *Id.*

2 (U. S. C. C. A., S. D. 1901)

The land department of the United States, including in that term the secretary of the interior, the commissioner of the general land office, and their subordinate officers, constitutes a special

tribunal, vested with judicial power to hear and determine the claims of all parties to the public lands, subject to its disposition, and with power to execute its judgments by issuing patents to the parties entitled to them. Judgment (C. C. 1900) 104 F. 430, reversed.— King v. McAndrews, 111 F. 860.

3 (Neb. 1901)

The law of accretion applies to the Missouri River, notwithstanding that, owing to the swiftness of its current and the softness of its banks, the changes are more rapid and extensive than in most other rivers.— De Long v. Olsen, 88 N. W. 512.

4 (Nev. 1902)

The doctrine of riparian rights does not prevail in Nevada.— Walsh v. Wallace, 67 P. 914.

5 (Iowa, 1902)

Where an island springs up in the midst of a stream, it is an accretion to the soil in the bed of the river, and not to the land of the riparian owner.— East Omaha Land Co. v. Hansen, 90 N. W. 705.

6 (La. 1902)

Where, after submergence, the water disappears from the land, either by gradual retirement or elevation of the land by natural or artificial means, and its identity can be established by reasonable marks, or by situation or boundary lines, the proprietorship returns to the original owner.— Hughes v. Birney's Heirs, 32 So. 30.

7 (La. 1902)

Where a point in the Mississippi River was gradually worn away and submerged, and thereafter the land reappeared and became to an extent susceptible of habitation and cultivation, the doctrine of reappearance of land after submergence controls, and the principles governing the acquisition of land by accretion or dereliction have a bearing upon the case, though not strictly determinative of the controversy.— Hughes v. Birney's Heirs, 32 So. 30.

8 **(Mo. 1902)**

The erection by a riparian owner on a fresh-water navigable stream of a permanent building between high- and low-water mark is not unlawful as a material interference with navigation.— State *ex. rel.* Citizens' Electric Lighting & Power Co. v. Longfellow, 69 S. W. 374.

9 **(Mo. 1902)**

A riparian owner on a fresh-water navigable river owns to low-water mark, subject to the rights of the public as regards the navigation of the stream.— State *ex. rel.* Citizens' Electric Lighting & Power Co. v. Longfellow, 69 S. W. 374.

10 **(Cal. 1902)**

On an issue as to the location of the banks of a river, it appeared that at varying distances on each side of the water channel there were elevations of land, and that at times the whole of the space between the elevations and the lines of the usual water channel was covered with water. Such space was a level plat; the nature of the soil being, in general, similar to the bed of the usual water channel. Some parts of the space had been cultivated. *Held,* that the banks of the stream were the elevations beyond the lines of the usual channel.— Ventura Land & Power Co. v. Meiners, 68 P. 818.

MICHIGAN ENGINEERING SOCIETY.

BUSINESS TRANSACTIONS AT THE TWENTY-FOURTH ANNUAL CONVENTION.

The business meeting of the Engineering Society was held Wednesday evening, January 21.

The Secretary read the annual report of the Board of Directors, which was approved by the Society, and is as follows:

ANNUAL MEETING OF BOARD OF DIRECTORS.

CLIMAX, MICH., Sept. 17, 1902.

The annual meeting of the Board of Directors of the Michigan Engineering Society was held at Hotel Downey, in Lansing, Wednesday, Sept. 17, 1902. There were present, President Sears, Director Riggs, Secretary Hodgman and members A. L. Holmes, A. C. Lane and H. K. Vedder.

The Treasurer's annual report was read and approved. The Secretary's report was read and accepted.

Ballots for officers for the ensuing year were canvassed, and the following found and declared elected:

President, M. E. Cooley, of Ann Arbor.

Vice-President, A. L. Holmes, of Grand Rapids.

Secretary-Treasurer, F. Hodgman, Climax.

Directors: A. C. Lane, of Lansing; J. B. Davis, of Ann Arbor; and Dorr Skeels, of Grand Rapids.

The applications for membership of H. R. Allen and C. A. Ensign were received, and they were approved for senior membership.

The application of C. Palmer for withdrawal was granted. The application of Dorr Skeels for withdrawal was received, and action deferred. On motion of Director Lane, it was resolved that the application is received with great regret, and in view of his election as director by a large majority, they trust that he will continue his services as an active member for a time longer before passing into the class of honorary members, to which his long and faithful services to the Society fully entitle him.

The membership of E. Nicholson was annulled for refusal to pay dues. The memberships of F. H. Brown, R. J. Hill, Owen Morris and A. S. Van de Mark were annulled for non-payment of dues. In the case of E. F. Bradt, on motion of Director Lane, it was voted to defer action until after Director Lane could communicate with him. The Secretary would now say, as the result, Mr. Bradt's dues have been paid in full and his membership retained. Action was also deferred in the case of Geo. M. Brown.

It was voted to hold the next annual convention in Battle Creek, Jan. 20, 21 and 22, 1903.

F. HODGMAN, *Secretary.*

The Treasurer's annual report above referred to is as follows:

TREASURER'S ANNUAL REPORT.

CLIMAX, MICH., Sept. 17, 1902.

To the Board of Directors of the Michigan Engineering Society.

The Treasurer would respectfully report that since the last annual report he has received and expended for the Society the following sums:

Cash on hand, Sept. 19, 1901	$263 27	
Received for advertising	336 99	
Received for annual dues	330 00	
Received for postage on exchanges	51 60	
Received for Reports sold	48 85	
Received for membership fees	37 00	
Received for reprints of papers	16 10	$1,083 81

Expenditures.

Paid for printing 2,100 "Engineers," including cuts and reprints	$ 314 15	
Paid for miscellaneous printing	31 70	
Paid for Secretary, as voted	300 00	
Paid for postage	108 43	
Paid for expenses of Board of Directors	13 62	
Paid for freight, express and dray	12 14	
Paid for commission on ads	7 00	
Paid for American Digest	4 00	
Paid for envelopes	2 25	
Paid for copyright	1 10	
Cash on hand, Sept. 17, 1902	289 39	
		$1,083 81

The Society owes nothing. There is due it from advertisers, $20; from eleven members, one year's dues each, $33; from T. W. Barally, S. E. Jarvis and R. C. Smith, two years' dues each, $12; from E. F. Bradt, Geo. M. Brown, F. H. Brown, R. J. Hill, Owen Morris and A. S. Van de Mark, three years' dues each, $54. Those more than two years in arrears for dues have been notified as required by the laws of the Society. No response has been received, and their membership should be annulled.

F. HODGMAN, *Treasurer.*

The following is the Secretary's report:

SECRETARY'S ANNUAL REPORT.

CLIMAX, MICH., Sept. 17, 1902.

To the Board of Directors of the Michigan Engineering Society.

I would respectfully report the following business transacted by me for the Society since the last report:

Immediately after the Grand Rapids Convention, the job of printing our annual report, the MICHIGAN ENGINEER, was let to the Review and Herald Publishing Co., of Battle Creek. By an unfortunate accident, the stenographer's report of the convention was destroyed and the Society was left without any report of the oral proceedings of the convention. The President, Secretary, and Director Skeels met and prepared as complete a report as was possible under the circumstances.

The ENGINEER was gotten out in good season. 2,100 copies were printed.

Several new exchanges have been added to our list this year, and some seem to have fallen out. We now have sixteen exchanges on our list, with two more in good prospect, which I expect to receive during the year.

The work of securing ads was, as usual, mainly done by the Secretary, but some assistance was received from A. C. Lane, Chas. Holmes, A. L. Holmes, H. E. Riggs and Geo. F. Bristol. Such assistance has usually come free. When special solicitors have been employed they have been paid a commission on their orders. Some of our members have done a good deal of work soliciting ads, with small returns. None of them have ever asked anything more than pay for the postage stamps they used, and

not many of them have asked that, but I suggest to you the question whether they ought not to be allowed a commission on all orders which they secure. Ballots for members were sent out the first Monday in March, and the result of the ballot announced in the ENGINEER. The applications for membership of H. R. Allen and C. A. Ensign were received too late for this year's ballot. They are herewith submitted for your action.

Letter ballots for officers for the ensuing year were sent out August 15. So many of them as have been returned are herewith submitted for canvassing.

Charles Palmer and Dorr Skeels have made application to withdraw from the Society. Their dues are paid in full, and they are entitled to have their applications granted. In view of Mr. Skeels' long, faithful and meritorious services to the Society during its entire existence, I would suggest that his name be presented to the Society for honorary membership.

In the Treasurer's report are given the names of those whose membership should be annulled for nonpayment of dues. There is another member whose case I submit for consideration, that of E. Nicholson, of Kalamazoo. In response to the annual statement of dues sent him, he replied that he was going to quit the Society and would not pay his dues. And he has not. What shall be done? It would seem as if the members of this Society ought to understand that it is a legal incorporation, with power to enforce its laws if it chooses to do so, and that it is as dishonorable for a member to attempt to slink out of the Society, leaving its bills to be paid by the remainder, as it is for a partner in a mercantile or any other corporation to attempt the same thing. There is an honorable way provided for withdrawal from the Society; and there is also a dishonorable one.

I submit herewith some correspondence relative to joining the Association of Engineering Societies. Through its system of exchanges, this Society is now to all practical intents and purposes a member of such an association. Herewith I give the comparative advantages of the two associations, taking that of the Associated Societies from their statement. In each item, the Association of Engineering Societies is given first:

	Association of Eng. Societies.	Michigan Eng. Societies.
Number of Societies represented	11	17
Membership	About 1,500	About 2,000
Pages of Pooceedings and Papers	" 800	" 3,000
Circulation	" 2,000	" 2,100

Cost of publication to members, aside from dues, $3.00 a year; 50 cents to $1.00 for postage.

This does not include two societies with whom we expect to exchange this year, but not now settled.

In this connection, I would suggest that if we continue our present system of exchanges it will be necessary to collect more than fifty cents, as has been done for postage on them. That amount has already been expended this year, and there are half of our exchanges yet to be received. Would it be well to raise the annual dues one dollar, and drop the special assessment for postage? F. HODGMAN, *Secretary.*

On motion of E. W. Muenscher, it was voted to pay the Secretary $300 for the past year's services.

The Society then proceeded to nominate candidates for the several offices to be elected by letter ballot. For president, A. L. Holmes, of Grand Rapids, was nominated; for vice-president, Dorr Skeels, of Grand Rapids; for secretary-treasurer, F. Hodgman, of Climax.

Mr. J. J. Hubbell called attention to the desirability of having one director elected each year to hold office for three years, and desired to know if action could not be taken at this meeting to bring about the change. The question was referred to the Secretary for an answer.

MR. HODGMAN: "It can only be done by disincorporating the Society. This matter was fully looked up when the Society was incorporated under a special act of the legislature, and it was found that the State constitution did not permit it. As it now stands, we are an incorporated body, having all the rights, powers and liabilities of any incorporated business association. If the officers of the Society contract for the publication of the anuual report, there is a responsible body back of them bound to pay for it. If a member fails to pay his dues or assessments, the Society can collect it from him if he is worth it. We can only elect directors in the manner suggested by giving up our business standing, and the Society has not hitherto thought it worth while. In fact, during the sixteen years that we have been incorporated the present Secretary and Messrs. Davis and Skeels have been on the Board of Directors nearly all the time, and we have never had a complete change in its membership.

The nomination of candidates was resumed, and the following members named as candidates for directors: Geo. S. Pierson, of Kalamazoo; Prof. A. C. Lane, of Lansing; Prof. H. K. Ved-

der, of Agricultural College; Prof. J. B. Davis, of Ann Arbor; E. W. Muenscher, of Manistee; and M. Walker, of Fenton.

The several committees were revised and rearranged as follows:

No. 1.— On the Relation of Sewerage and Water Supply to the Public Health: Geo. S. Pierson, Kalamazoo; H. E. Riggs, Toledo; Frank F. Rogers, Port Huron.

No. 2.— On Forestry: continued the same.

No. 3.— On Engineering Features of Municipal Work to Be Protected by Ordinance: W. W. Brigden, Battle Creek; W. J. Sherman, Toledo, Ohio; E. W. Muenscher, Manistee.

No. 4, on Roads and Paving, and No. 5, on Questions in Land Surveying, were continued.

No. 6, on Advertising, and No. 7, on the Press, were discontinued.

No. 8, on Topographical Survey of the State, was continued. Professor Lane of that committee stated that they had not succeeded in securing any appropriation from the state for that work. Some work in the vicinity of Ann Arbor had, however, been done in connection with the U. S. Geological Survey, and sheets of that work were promised in the near future. He also called attention to a topographic map of one of the western counties, which had only cost him a couple of hundred dollars. It was largely made from a lot of railroad levels.

Mr. Riggs: I want to say for the benefit of the members who may not appreciate the value of the work, that work is being done for the State of Ohio. There are already completed now in the neighborhood of our city of Toledo enough sheets to give us a continuous map of a hundred miles by forty, and we find it of the very greatest value, not only in railway location, but in all classes of engineering work. Something less than a year ago our office sent for one hundred copies of the sheets for immediate contingencies. They are sold at thirty cents each by the government, and they were sold by us at the same price. They are of value to every surveyor, and they are valuable in a hundred different ways. If the work could be done for the whole state, it would be of the very greatest value.

Professor Davis reminded the Society that a very excellent topographic map of Michigan had been made many years ago by Farmer.

MR. HODGMAN: I think topographical sheets by counties were published by the state geologist in Houghton's time. I have one of them of Calhoun County, which was given me by the late Dr. Manly Miles more than forty years ago.

MR. LANE: I move that the committee be authorized to make such selection as they see fit of localities in the state in which to have the first sheets made, and that the Society aid with their advice and suggestions. Carried.

On motion of Mr. Brigden, it was voted to have a committee on electric railways, and Messrs. Wm. G. Fargo, of Jackson; M. C. Taft, of Kalamazoo; W. W. Brigden, of Battle Creek; and Henry F. Bean, of Jackson, were elected to serve in that committee.

The Secretary announced the receipt of a letter from Mrs. Jennie Watkins Copeland, which was read and referred to a special committee, consisting of Dorr Skeels, F. Hodgman and J. B. Davis. After considering the matter, the committee made the following report, which was adopted by the Society, and the Secretary ordered to communicate the same to Mrs. Copeland:

COMMITTEE'S REPORT.

The Michigan Engineering Society learns by the following letter, and with deep regret, of the death of one of its honorary members, John J. Watkins, of Guthrie, Okla.:

AT HOME ON MY FATHER'S FARM, ONE-HALF MILE
NORTH OF GUTHRIE, OKLA.,
Jan. 20, 1903.

F. Hodgman, Climax, Mich.

DEAR SIR: I received a notice a few days since addressed to my father, of the annual convention of the Michigan Engineering Society, of which my father was an honorary member, I believe.

As there have several communications come to him of late from your Society, I have concluded that they were not cognizant of his death, which occurred Aug. 5, 1902. I thought at the time I sent you a notice of his death. My poor father has

gone to that land from whence there is no returning. As I am the only one of his children that has been here in the Territory with him, having kept house for him for ten years, through the six years of his invalidity, I have been his constant companion, reading to him, riding with him, assisting him in his business, so his home seems very empty without him. My hands are idle, from a loving work, and the world seems almost a blank. His life was so pure and upright in all things, we can truly say we honor his memory.

He held you and the Society in loving remembrance, always so pleased to receive any periodical from them, and ever tried to keep in close touch with them. I know he has kept up a correspondence with you all these years. It had been my intention to notify the convention of his death before their meeting, but expect I am too late.

Very truly,

JENNIE WATKINS COPELAND.

Mr. Watkins was one of the charter members of the Michigan Engineering Society. He was, in the earlier years of its existence, one of its most active and efficient members, working at all times for its best interests and advancement, and contributing freely to its literature. He was warm-hearted and sensitive in his nature, but tenacious in upholding whatever he believed to be right. In his death the Society has lost a member whom they were glad to honor. They extend to his relatives and friends their sincere sympathy and condolence.

DORR SKEELS,
F. HODGMAN,
J. B. DAVIS.

The Secretary presented a communication from H. F. Bean and A. B. Stevens to hold the next convention in Jackson, which was received, and the thanks of the Society returned.

The following resolution was reported by the Committee No. 1, and adopted by the Society:

Whereas, There is no legislative enactment of the state of Michigan giving the State Board of Health any power to protect the purity of the inland waters of the state, and whereas the in-

terests of public health demand that some proper action be taken to restrain the pollution of streams by the discharge into them of sewage and garbage.

Therefore be it resolved by the Michigan Engineering Society in convention assembled, That the legislature of Michigan be respectfully petitioned to enact such laws as will require the approval of the State Board of Health to all sources of public water supply and to all outlets of sewers; and, further, that a copy of all plans for new systems of water works and sewerage be filed with the said board; and, further, that no system of sewage disposal or water purification be established without full approval of all plans by the State Board of Health.

The following request was presented by Prof. J. B. Davis and adopted by the Society, and the Secretary directed to communicate it to the Commissioner of the State Land Office:

Hon. Edwin A. Wildey, Commissioner, State Land Office, Lansing, Mich.

SIR: The Michigan Engineering Society has learned of the completion of the St. Clair Flats Survey. The Society is informed that this work embraced many unusual details, of interest to all engineers who may be called upon to undertake a similar work. The Society desires to be informed when and where the final reports of this work will be published, with a view of obtaining copies of the same for its own membership, as well as of notifying through its own publication the other sixteen societies with whom it exchanges, whose membership, with the membership of this Society, numbers over two thousand.

This Society highly appreciates the appropriateness of the service to the profession which the publication of these reports would have, coming from your office, which took so important a part in the reorganization of the Michigan Engineering Society upon a basis which has proved one of continuous prosperity for more than twenty years. The most useful part of Mr. Sherman, who was in your office in 1880, is here referred to.

The Committee on Exhibits made the following report, which was approved by the Society:

To the President and Members of the Michigan Engineering Society.

Your Committee on Exhibits would respectfully report that they have examined a large and fine exhibit made by Keuffel & Esser, of Chicago, consisting of drawing instruments of all kinds, steel and metallic tapes, hand levels, slide rules, a very convenient folding reading rod and a finely finished engineer's transit and wye level, and take pleasure in testifying to their excellent quality and finish, and in recommending them to members of the Society having occasion to purchase.

G. M. Ames,
H. E. Riggs,
E. W. Muenscher,
Committee.

A special meeting of the Board of Directors was held on Thursday, Jan. 22, 1903.

The applications for membership of L. W. Anderson, Warren A. Hoyt, L. A. Waterbury, N. D. Whitman and Edward Hoyt were received and approved for senior membership. The application of J. R. McCammon was received and approved for junior membership. The application of Charles Holmes for withdrawal was granted. The application of Geo. A. Dingman for membership was received later and submitted to the directors by letter, and approved for junior membership. The above applicants were all elected by letter ballot sent out March 2, 1903, and canvassed by the Secretary, April 6, 1903.

F. Hodgman, *Secretary.*

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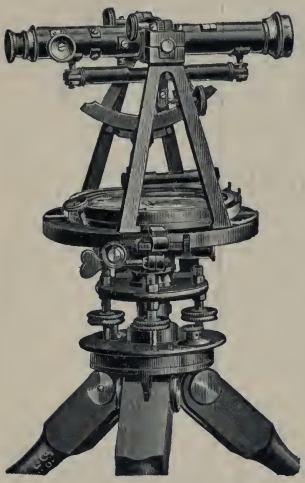

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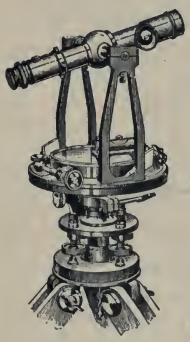

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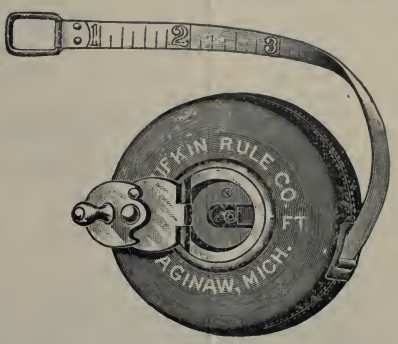

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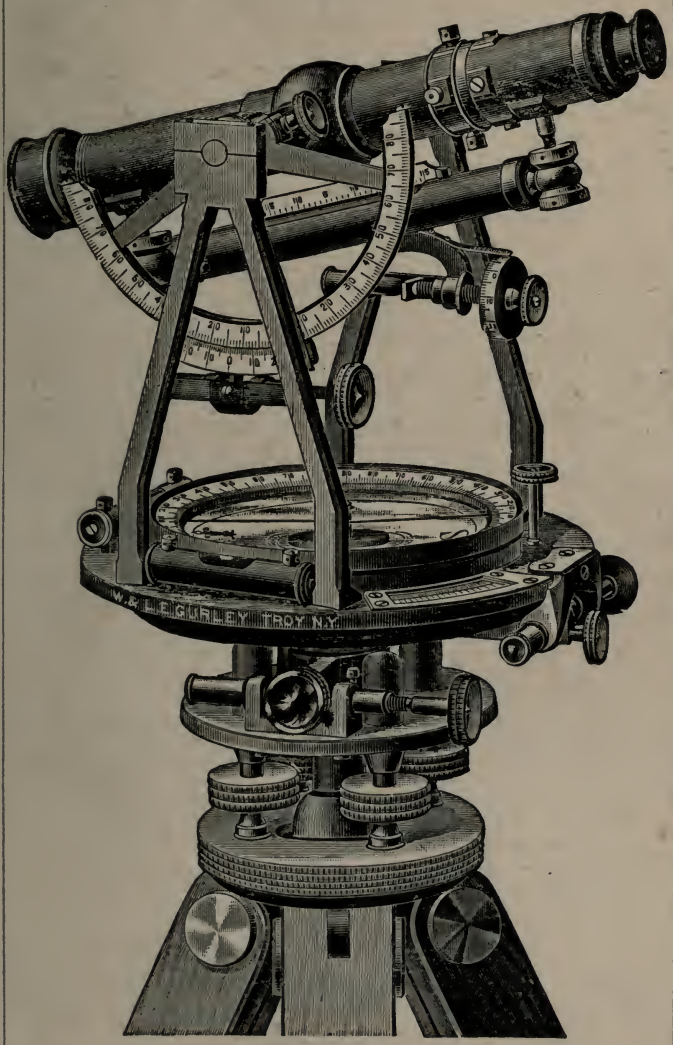

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